Journal of the Royal Society of Arts

NO. 5033 APRIL 1959 VOL. CVII

FORTHCOMING MEETINGS

WEDNESDAY, 15TH APRIL, at 2.30 p.m. FERNHURST LECTURE. '*The Biological Control of Agricultural Pests*', by G. C. Varley, M.A., Ph.D., Hope Professor of Entomology, University of Oxford. E. O. Pearson, M.A., Director, Commonwealth Institute of Entomology, will preside. (The paper will be illustrated by lantern slides.)

THURSDAY, 16TH APRIL, at 5.15 p.m. COMMONWEALTH SECTION. HENRY MORLEY LECTURE. '*Britain and the Technical Development of Eastern Countries under the Colombo Plan*', by W. Railston M.Sc., Ph.D., F.Inst.P., Scientific Adviser to the Colombo Plan Department, Commonwealth Relations Office. Sir Willis Jackson, D.Sc., D.Phil., F.R.S., M.I.E.E., M.I.Mech.E., F.Inst.P., Director of Research and Education, Metropolitan-Vickers Electrical Co. Ltd., will preside. (The lecture will be illustrated by lantern slides. Tea will be served in the Library from 4.30 p.m.)

MONDAY, 20TH APRIL, at 6 p.m. The first of three CANTOR LECTURES on '*Research in Textiles*', entitled '*Research in Wool*', by J. B. Speakman, D.Sc., F.R.I.C., F.T.I., Professor of Textiles Industries, University of Leeds.

WEDNESDAY, 22ND APRIL, at 2.30 p.m. '*Recent Developments in Packaging*', by Milner Gray, R.D.I., PP.S.I.A. John Gloag, Hon.A.R.I.B.A., Hon.F.S.I.A., a Member of Council of the Society, will preside.

THURSDAY, 23RD APRIL, at 5.15 p.m. COMMONWEALTH SECTION. '*The Uranium and Thorium Resources of the Commonwealth*', by S. H. U. Bowie, B.Sc., M.I.M.M., of the Atomic Energy Division, Geological Survey of Great Britain. Anton Gray, Senior Mining Adviser, Atomic Energy Authority, will preside.

MONDAY, 27TH APRIL, at 6 p.m. The second of three CANTOR LECTURES on '*Research in Textiles*', entitled '*Research in Cotton*', by J. J. Vincent, M.Sc., F.T.I., Professor of Textile Technology, Manchester College of Science and Technology.

MONDAY, 4TH MAY, at 6 p.m. The last of three CANTOR LECTURES on '*Research in Textiles*', entitled '*Research in Man-Made Fibres*', by J. R. Whinfield, C.B.E., M.A., F.R.I.C., of Imperial Chemical Industries Ltd.

WEDNESDAY, 6TH MAY, at 2.30 p.m. TRUEMAN WOOD LECTURE. '*The Growth and Scope of Industrial Design in the United States*', by Walter Dorwin Teague, Hon.R.D.I. Sir Alfred Bossom, Bt., LL.D., F.R.I.B.A., J.P., M.P., Chairman of Council of the Society, will preside.

WEDNESDAY, 13TH MAY, at 2.30 p.m. '*The Work of the Historic Churches Preservation Trust*', by the Right Honble. the Earl of Euston, Chairman, Society for the Protection of Ancient Buildings. The Right Honble. Viscount Crookshank, P.C., C.H., will preside.

WEDNESDAY, 20TH MAY, at 2.30 p.m. '*Trade and the Bamboo Curtain*', by the Right Honble. the Earl of Verulam. Sir Alexander Grantham, G.C.M.G., late Governor of Hong Kong, will preside. (The paper will be illustrated by lantern slides.)

WEDNESDAY, 27TH MAY, at 2.30 p.m. '*The Development of the Port of London*', by Sir Leslie Ford, O.B.E., General Manager, Port of London Authority. John Hay, M.P., Parliamentary Secretary, Ministry of Transport and Civil Aviation, will preside.

WEDNESDAY, 3RD JUNE, at 2.30 p.m. '*The Psychiatrist's Contribution to Medicine*', by D. Stafford-Clark, M.D., F.R.C.P., D.P.M. Sir Selwyn Selwyn-Clarke, K.B.E., C.M.G., M.C., M.D., F.R.C.P., M.R.C.S., a Member of Council of the Society, will preside.

Fellows are entitled to attend any of the Society's meetings without tickets (except where otherwise stated), and may also bring two guests. When they cannot accompany their guests, Fellows may give them special passes, books of which can be obtained on application to the Secretary.

THOMAS GRAY MEMORIAL TRUST

PRIZE FOR A DEED OF PROFESSIONAL MERIT

In recognition of the remarkable skill which is so constantly displayed at sea, the Council of the Royal Society of Arts, which administers the Thomas Gray Memorial Trust, offers again this year the Society's Silver Medal for a deed of outstanding professional merit by a member of the British Merchant Navy. The period to be covered by the offer will be the year ending 30th September, 1959, and deeds of a character worthy to be considered for the award may be brought to the notice of the Council by any person not later than 31st December, 1959. They will not, however, be considered by the judges unless they have been endorsed by a recognized authority or responsible person able to testify to the deed to be adjudged.

The Council reserves the right to withhold the above award at its discretion.

The prize of the Society's Silver Medal offered in 1958 for a Deed of Professional Merit was not awarded, as none of the submissions was considered to be sufficiently outstanding.

EXHIBITION OF BURSARY DESIGNS

The exhibition of winning and commended designs in the 1958 Industrial Art Bursaries Competition will be held from Monday, 27th April until Friday, 15th May. It will be shown, not in the Library, as in previous years, but in the Exhibition Rooms on the first floor of the Society's extension premises, *which are reached from 18 Adam Street*. This is the first exhibition to be held in the new rooms and, apart from the interest of the designs themselves, it therefore has a special significance. The hours of viewing are as follows: Mondays to Fridays, from 10 a.m. to 5.30 p.m.; Saturdays, from 10 a.m. to 12.30 p.m.

Special cards of admission will be required for the opening, which will be performed by Sir Harry Pilkington, Chairman of Pilkington Brothers Ltd., at 4.30 p.m. on 27th April (tea will be served in the adjoining room from 4 p.m.). Although the majority of these cards must be issued to those who are directly concerned with the organization of the Competition, it is expected that a number will be available for other Fellows. Applications for them should be made to the Bursaries Officer by 20th April.

MEETING OF COUNCIL

A meeting of Council was held on Monday, 9th March, 1959. Present: Sir Alfred Bossom (in the Chair); Mrs. Mary Adams; The Honble. G. C. H. Chubb; Sir Edward Crowe; Mr. R. E. Dangerfield; Sir George Edwards; Mr. Peter Le Neve Foster; Mr. E. Maxwell Fry; Mr. John Gloag; Mr. A. C. Hartley; Mr. William Johnstone; Sir Harry Lindsay; Mr. Oswald P. Milne; Lord Nathan; the Earl of Radnor; Mr. Paul Reilly; Sir Gilbert Rennie; Sir Selwyn Selwyn-Clarke; Professor S. Tolansky; Mr. G. E. Tonge; Mr. H. A. Warren and Sir Griffith Williams; with Dr. K. W. Luckhurst (Secretary) and Mr. G. E. Mercer (Deputy Secretary).

ELECTIONS

The following candidates were duly elected Fellows of the Society:

Bawden, Frederick Charles, F.R.S., Harpenden, Herts.
Beline, George, New York City, N.Y., U.S.A.
Bound, Rowland Henry, F.R.Ae.S., M.I.Mech.E., Cheltenham, Glos.
Callcut, Derrick Arthur, Hove, Sussex.
Chenery, Alexander Frank, London.
Chester, Rex, B.A., London.
Chi, Richard See-Yee, B.Sc., Bristol, Glos.
Clements, John Selby, C.B.E., London.
Darvall, Air Marshal Sir Lawrance, K.C.B., M.C., Sevenoaks, Kent.
Davies, David Thomas, North Wembley, Middx.
Dottorrer, Paul Reigner, B.S., New York, N.Y., U.S.A.
Dove, Alan Raymond, M.A., Rochdale, Lancs.
Dunnett, George Sinclair, C.M.G., O.B.E., London.
Dunning, John Ernest Patrick, M.A., F.R.Ae.S., Aylesbury, Bucks.
Gardner, Alan Thomas, B.Sc., D.I.C., A.R.C.S., A.M.I.Chem.E., Whitley Bay, Northumberland.
Goodden, Wyndham, O.B.E., Hon.Des.R.C.A., Nayland, Suffolk.
Gurr, Kennett Bruce, Folkestone, Kent.

Hardaker, John Christopher Keith, N.D.D., London.
Henshall, John, Stockport, Cheshire.
Hickson, Alfred Benjamin, Middlewich, Cheshire.
Hinton, Derek Victor, Leeds.
Hoffman, Edmund Theodore Stanley, M.A., East Croydon, Surrey.
Johnston, James Greer, Dunedin, New Zealand.
Laughton, Anthony Seymour, M.A., Ph.D., Godalming, Surrey.
Mansell, Robert Freeman, Croydon, Surrey.
Mason, Miss Angela Raymonde, Leatherhead, Surrey.
Megoran, Winston, Weymouth, Dorset.
Moyes, William Arthur, B.A., M.Ed., Peterlee, Co. Durham.
Newbatt, John Edward, East Horsley, Surrey.
Payne, Mrs. Dorothy Edith Willmer, Reigate, Surrey.
Pirie, Norman Wingate, F.R.S., Harpenden, Herts.
Reed, Miss May, B.Sc., Ingatestone, Essex.
Shoobert, Sir Harold, C.I.E., E.D., Dorking, Surrey.
Snelgrove, Louis Edward, M.A., M.Sc., Weston-super-Mare, Somerset.
Summers, Francis William George, London.
Stahl, William Martin, Jr., A.B., M.D., F.A.C.S., Danbury, Connecticut, U.S.A.
Tweedie, John, B.A., Watchet, Somerset.
Wade, John Francis, Coulsdon, Surrey.
Wemyss, Andrew Michael John, London.
Wood, Alfred William, D.F.C., B.E.M., Assoc.I.E.E., London.
Wood, Frank, M.A., LL.B., Bramhall, Cheshire.

ALBERT MEDAL FOR 1959

Preliminary consideration was given to the award of the Society's Albert Medal for 1959.

THOMAS GRAY MEMORIAL TRUST

The report of the responsible committee on the activities of the Thomas Gray Memorial Trust for 1958 was received, and its proposals for 1959 were approved.

PROPOSED ANNUAL RECEPTION

A committee was set up to inquire into the possibility of establishing an annual reception for Fellows of the Society.

EXAMINATIONS

It was reported that 43,945 entries had been received for the spring series of examinations, an increase of 6,549 over the corresponding 1958 figure.

R.D.I. JOINT COMMITTEE

The following were appointed as the Council Members of the R.D.I. Joint Committee for the ensuing twelve months:

Sir Ernest Goodale (*Chairman*)
Mrs. Mary Adams
Sir Alfred Bossom
Mr. John Gloag
Mr. F. A. Mercer
Mr. Oswald P. Milne

OTHER BUSINESS

A quantity of financial and other business was transacted.

ILLUSIONIST DECORATION IN CENTRAL ITALIAN PAINTING OF THE RENAISSANCE

The Fred Cook Memorial Lecture by

SIR ANTHONY BLUNT, K.C.V.O.,

Professor of the History of Art, University of London, and Director, Courtauld Institute of Art, delivered to the Society on Wednesday, 28th January, 1959, with Ellis K. Waterhouse, C.B.E., M.A., Barber Professor of Fine Arts, and Director of the Barber Institute, University of Birmingham, in the Chair

THE CHAIRMAN: It seems to me exceedingly odd to be required to introduce to you Professor Sir Anthony Blunt, partly because I cannot remember when I did not know him! He will be well known to you as Keeper of the Queen's pictures and in the rôle of Director of the Courtauld Institute—which really dictates what is going to happen to the arts in this country in the coming generation. I am not quite sure for how long he has been interested in the subject which he has taken for his afternoon, but certainly it has been for a considerable time, since I can remember, almost exactly a quarter of a century ago, when he and I visited many of the monuments which I hope we shall look at this afternoon. Some of the palace decorations were rather less accessible then than they are to-day, and my memory chiefly goes back to many extremely laughable incidents which occurred when we finally got in to see them and were shown round by rather curious owners or tenants or persons who made it difficult for us to concentrate on what we wanted to look at. In retrospect, however, I do not think that any of those troubles will recur to Professor Blunt's mind to-day!

The following lecture, which was illustrated by lantern slides, was then delivered.

THE LECTURE

There are many different ways of decorating the surface of a structural feature, such as a wall, a vault or a dome; but in all the systems used since classical antiquity two basically different principles can be distinguished. One method is to accept and indeed emphasize the wall itself, and to ornament it with such details as low-relief decoration or small painted panels which do not in any way distract the eye from the real surface of the structure. The other is to conceal the solid structure, to make the spectator forget its existence and to lead him to think that it has been spirited away and replaced by something different. This can be achieved by architectural means, as was done by Michelangelo in the Ricetto of the Laurenziana, or by the use of high-relief sculpture, as in much South Italian or Spanish Baroque, but it can also be done with great effect by

the use of illusionistic or *trompe l'oeil* painting, and it is the use of such methods at the time of the Italian Renaissance that I propose to discuss in this lecture.

Generally speaking, Italian artists of the fourteenth and fifteenth centuries accepted the existence of the wall and decorated it either with a series of frescoes, one above the other, applied to the wall like separate panels without any attempt at consistent perspective, or with a single scene which, though it can be regarded as a view through a window, does not in fact provoke this idea in the mind of the spectator.

There were, however, exceptions. Even Giotto, in the Arena Chapel frescoes, paints the Virtues and Vices on the dado as if they protruded beyond the niches in which they appear to stand and were suspended in front of the wall itself. This method is taken up and used on a larger scale in the fifteenth century by Castagno, whose Famous Men and Women from the Villa Carducci all emerge from their niches and intrude into the room itself.[1]

This method of decoration rapidly spread throughout Italy. In the 1480s Melozzo da Forli applied it with great boldness to the decoration of a dome in the Sacristy of the church at Loreto. Here a row of prophets sit on a painted cornice against painted relief decorations on the real surface of the octagonal cupola, and above them painted angels hover in front of feigned windows which open on to a painted blue sky.

In Lombardy the young Bramante decorated the façade of the Palazzo del Pretore in Bergamo (1477) and the Casa Panigarola in Milan (1480s) with figures in sham niches, and, in the foreshortened apse of S. Maria presso S. Satiro at Milan, produced one of the boldest deceptions before the time of Borromini. This example is outside the field of this lecture, because it was achieved in three-dimensional architecture and not on the flat, but it must certainly have provided a great stimulus to painters.

Illusionism on a smaller scale was developed at about the same time, for instance by Borgognone, who depicted Carthusian monks peeping through windows in the transept of the Certosa of Pavia (1492), and by painters who show an open window or door of a cupboard in steep perspective. Pinturicchio uses this trick in the Appartamento Borgia, where he shows a papal tiara and other ornaments in an open cupboard[2], but the great exponents of the device were the craftsmen who specialized in *tarsia* work for the decoration of dados or choir stalls. The most famous of these was Fra Giovanni da Verona, who made the panelled dado of Raphael's Stanza della Segnatura which was destroyed during the Sack of Rome, and also the magnificent choir stalls at S. Maria in Organo at Verona and at Monteoliveto Maggiore, which survive and testify to his almost incredible skill in this craft.[3] In the very last years of the century Leonardo da Vinci made a spectacular new application of the principle of illusionism in his decoration of the *Sala delle Asse* in the Castello Sforzesco at Milan by transforming the room into a sort of wood, the trees of which articulate the walls, while the branches meet overhead and intertwine to form the vaulting of the room.[4]

In Central Italy Signorelli introduces a new element, that of ambiguity, in his work at Orvieto. In the fresco of the *End of the World*, the scene seems at first to be painted on the flat wall between the inner and outer arches of the lunette; but Signorelli has destroyed the logic of the scheme by depicting a group of putti who stand on the inner arch and lower a painted *cartellino* apparently into the space of the chapel itself. At the bottom of the scene the breach with logic is even bolder, for the artist constructs a sort of platform which has the effect of pushing the outer arch back behind the inner one and allows a space on which the groups of tortured souls can struggle. In this way the upper and lower parts seem to be based on different assumptions about the construction of the space.

But the great exponent of illusionism in the fifteenth century is Mantegna, who is the first artist to give a complete and systematic illusionist effect to the decoration of a whole room. This is the *Camera degli Sposi* in the Gonzaga castle at Mantua begun in 1468 and finished in 1473. The basic assumption of this decorative scheme is that the walls of the room have been removed and that the vault is supported on pilastered piers, one at each corner and two on each wall. Between the capitals of these pilasters runs a rod carrying a curtain. On two of the walls, one containing a window, the curtains are painted as if they were drawn across and enclosed the room, whereas on the other two they are pulled aside and twisted round the piers to allow the eye to pass through to the view beyond. The left-hand wall shows the Marchese Lodovico Gonzaga meeting his son, Cardinal Francesco, and the figures are seen against a distant landscape. Over the door a group of putti hold up a *cartellino* with a dedicatory inscription. On the right-hand wall the view is more restricted. The scene shows the Marchese with his wife and family sitting in a garden enclosed by a panelled wall over which is a glimpse of trees and sky. In the left-hand fresco the figures stand on a narrow ledge, supposedly supported by the low dado of the wall; on the right the same principle is used, but the presence of a fireplace has forced the artist to raise the height of the ledge, so that some of the figures seem actually to be standing on the mantelshelf itself, while others walk down a short flight of steps ingeniously introduced on the right to vary the levels. In this panel the curtain is supposed to be drawn across, and some of the characters in the action push it aside as they appear from behind it. In the lunettes above the curtain rail shields and swags of fruit and leaves hang by ribbons from the tops of the arches. The lower part of the vault is decorated with feigned reliefs in grisaille centring round medallions of Roman emperors, but in the centre Mantegna once again shows great imagination and boldness. The vault is supposed to be cut away in a circular opening, like the *oculus* in the dome of the Pantheon, which was no doubt the source of his idea, but above this opening is constructed a balustrade over which peer a group of women and putti, while other putti stand on the ledge round the *oculus* itself or stick their heads through the openings in the balustrade. This ingenious arrangement has the incidental advantage that it allows Mantegna to display his skill in drawing figures in steep foreshortening.

Another work planned by Mantegna, but largely executed after his death, shows a less ambitious but interesting form of illusionism. This is the chapel in S. Andrea at Mantua, which contains the artist's tomb. Here the pendentives are cut away to allow the four Evangelists to sit in little semi-circular balconies against a background of fruit-trees and sky. The idea of the fruit garden is carried on into the dome, which is covered by a trellis with openings edged with garlands of flowers.

Historically the decoration of this chapel is of great importance, because one of Mantegna's pupils involved in its execution was probably Correggio, and it is certainly from this point that the young artist takes off in his career as a decorator which was to lead to some of the most revolutionary developments in the whole history of the genre.

The earliest of Correggio's great decorative schemes, the *Camera di San Paolo*, probably painted in 1518, is a brilliant variant on the scheme of Mantegna's chapel. The trellis, which rises from lunettes painted to look like half-domes enclosing statues, is pierced in every section by oval openings in which appear putti playing with stags, hounds and other attributes of Diana, to whom the room is dedicated and who is to be seen in her chariot over the fireplace. These putti exist in a world outside the room on, one must suppose, a kind of balcony running round the outside of the dome, but occasionally one of them sticks a leg or an arm through the opening into the space within the trellis-dome.

Correggio's next step was far more revolutionary. In the dome of S. Giovanni Evangelista, painted in 1520, he supposes that the whole cupola has been removed and replaced by a ring of apostles seated on clouds round the lower part of the space thus opened up, while in the middle hovers the figure of Christ, foreshortened so that, seen by one approaching up the nave, he appears to be ascending to the sky above him. This dome and the even bolder invention in the cathedral of Parma cannot detain us here, because their importance is for the history of Baroque decoration rather than for the art of the Renaissance.

Although the greatest innovations in illusionist decoration in the fifteenth century were made in the north of Italy, Rome also developed an important tradition. Its origins go back to the middle of the fifteenth century, the earliest surviving example of importance being a small room in the Vatican, the *Biblioteca Greca*, decorated about 1455 for Nicholas V by an artist probably belonging to the circle of Alberti (Figure 3*b*). Here it will be noticed the creation of illusionist space is achieved by means of feigned architecture, without the addition of figures, and with, as ornaments, only a few pieces of still-life ingeniously disposed on the architectural members. This method was continued in a number of decorative schemes executed in the late fifteenth century, such as those in the Palazzo Venezia, sometimes, but without good reason, connected with the name of Mantegna.[5] More remarkable is the series of frescoes, now, alas, sadly damaged and much restored, with which Innocent VIII decorated the loggia which he had added to the Belvedere.[6] In many ways these decorations derive from Mantegna's *Camera degli Sposi*, but they are novel in that the walls are opened up to show not groups of figures but open landscapes, the only figures being the

putti in the lunettes and, in the small room at the end of the loggia, groups of men singing occupying the same positions.

These broad landscapes must have been in the mind of Peruzzi, the great figure in the Roman part of this story, when he designed the celebrated *Sala delle Prospettive* for the villa of Agostino Chigi, now called the Farnesina, probably between 1510 and 1520 (Figure 1*b*). The walls of this room are decorated with a double colonnade which in the end walls allows a magnificent view on hills in one case and a town in the other. In this room the effect is of extreme subtlety, not only because of the boldness of the illusion, but because the perspective of all the walls is so calculated that the illusion is complete for someone standing at a point about five feet from the middle of the long wall with the windows. One is tempted to wonder whether this was the point at which the host's chair was placed, so that he at least could enjoy to the full the ingenuity of Peruzzi's creation.

The remaining rooms in the Farnesina were mainly decorated by other artists, but they contain so many illusionist devices not to be found elsewhere at this date that it is legitimate to think that the influence of Peruzzi, the guiding mind in the creation of the villa, spread even to those rooms where the execution was entrusted to independent painters. In the vault of the loggia or *Sala di Psiche*, for instance, painted by Raphael and his pupils, although certain elements go back to methods used by Mantegna, there are remarkable new features. The vault is divided up into sections by swags of fruit which recall the Mantegna decorations, but the two principal scenes—*Psyche presented to the Gods of Olympus* and the *Feast of the Gods*—are painted as if on a kind of awning or *velarium* stretched across the scaffolding formed by the swags, and tied to it at intervals so that the edge of the awning forms a series of cusps. Behind the awning and between the swags appears a background of blue sky. It is as if the loggia, which in its original form was open on one side, was also, by deceit, opened upwards to the sky and thus more completely fused with the garden on which it looked out.

If we go back to the first floor and through the *Sala delle Prospettive*, we come to a small room where yet other forms of illusionism await us. The two principal walls were decorated by Sodoma with scenes from the life of Alexander. On the wall facing the windows is the famous fresco of the *Marriage of Alexander and Roxana* which, as a decorative scheme, has one important and novel feature (Figure 6*b*). The lower part of the wall is filled not, as in the *Camera degli Sposi*, by a dado but by a painted balustrade which forms a barrier between the imagined space of the fresco and the real space of the room. But in the middle this barrier is broken, and the artist has painted a short flight of steps which invites the spectator to pass from one world to the other.[7]

On the right-hand wall the ambiguity is even more cleverly suggested (Figure 6*a*). The main fresco represents the *Family of Darius before Alexander*, but like Mantegna in the *Camera degli Sposi*, Sodoma was here faced with the intrusion of a fireplace which interfered with the levels of his paintings. He overcame this difficulty with remarkable ingenuity. In the *Sala delle Prospettive* Peruzzi had, logically enough, chosen to paint the *Forge of Vulcan* on the cowl over the fireplace. Sodoma—perhaps following a further lead from Peruzzi—

repeats this idea, but transfers it to the lower register of the wall, turning the real fire into the source of heat used by Vulcan and his assistants. The confusion—deliberate, of course—is now complete. Hitherto, we had been asked to believe that real walls had been dissolved and that the painted figures and landscapes on them were real. Now we are required to accept the idea that the painted putti are carrying their logs to the real fireplace, from which the imaginary Vulcan will produce his weapons. Will they be real or imaginary?[8]

Difficult as it may seem to associate this kind of trick with the classical spirit of Rome in the first decades of the sixteenth century, there is no doubt that it was more widespread than might be thought. In the ceiling of the Sistine Chapel, for instance, Michelangelo makes one suppose that the walls of the chapel are continued for another zone, which is articulated with piers and thrones on which sit Prophets, sibyls and *ignudi*. Even Raphael, in the loggie, uses forms of illusionist deception which, though they are child's play compared with those displayed in the Farnesina, are yet remote from what we should consider classical principles. In some bays the vault is conceived as composed of four solid elements supporting a central panel, while the corners are filled with either an illusionistically painted awning or a steeply foreshortened architectural structure leading up to the open sky. In the lower loggie, painted mainly by Giovanni da Udine about 1519, another device is used. The vault is replaced by a light trellis covered by an abundant vine on which sit birds and animals of various kinds. Behind is the blue of the sky (Figure 3*c*).

These instances are enough to show that even at the peak of the High Renaissance in Rome artists were ready to use in their decoration methods which seem the very reverse of the reasonable and logical principles of classicism. Can we find out why they did so, and from what sources they derived their ideas?

The answer to these questions seems to be that they found both models and justification for these methods in ancient Roman painting. It is, in fact, possible to find examples of nearly all the devices so far discussed in surviving works of ancient art. The figures which form the decoration of the great room in the Villa of the Mysteries at Pompeii, for instance, are disposed on a ledge over a painted dado like those in Mantegna's *Camera degli Sposi*. These frescoes, it is true, did not contain the landscape background introduced by Mantegna, but the decoration of the exedra in the House of Menander at Pompeii or that of The Villa of Livia from Prima Porta now in the Terme Museum, Rome, proves that the Romans sometimes introduced painted gardens into their wall decoration. Such a fresco may have been in Mantegna's mind when he planned his Mantuan decorations, though it must be borne in mind that late medieval art also provided examples of garden paintings as wall decoration, as in the *Garde Robe* of the Palace of the Popes at Avignon and in the Castello del Buon Consiglio at Trent. The hypothesis that a model like the Villa of Livia decoration was known at the time of the Renaissance is confirmed by a further connection. The fence along the bottom of the Roman fresco is in its function remarkably like the balustrade in Sodoma's *Alexander and Roxana*, even to the point of having a similar break in the middle, as if to admit a visitor from the room.

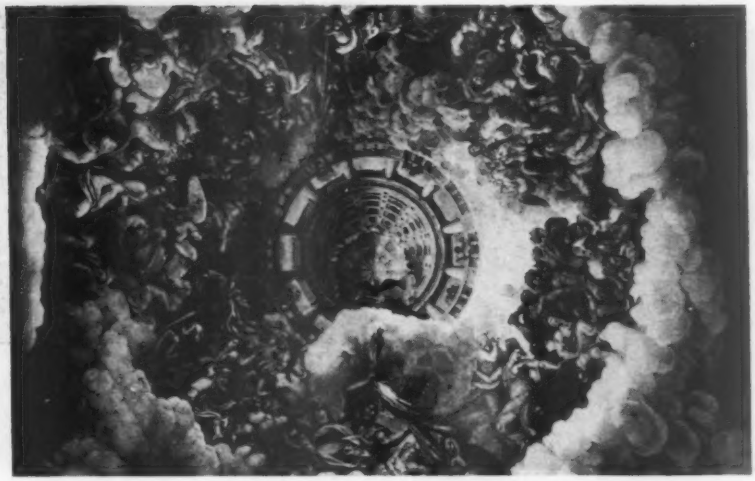


FIGURE 1*a*. Giulio Romano. *Sala dei Giganti. Palazzo del Tè, Mantua*

FIGURE 1*b*. Peruzzi. *Sala delle Prospettive. Villa Farnesina, Rome*

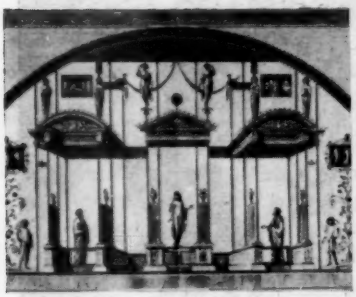


FIGURE 2a. *Decoration in the Golden House of Nero, Rome*

FIGURE 2b. *Stucco in the Villa Madama, Rome*

FIGURE 2c. *Vault mosaic, Sta. Costanza, Rome*

FIGURE 3a. *House of the Vettii, Pompeii*

FIGURE 3b. *Biblioteca Greca, Vatican*

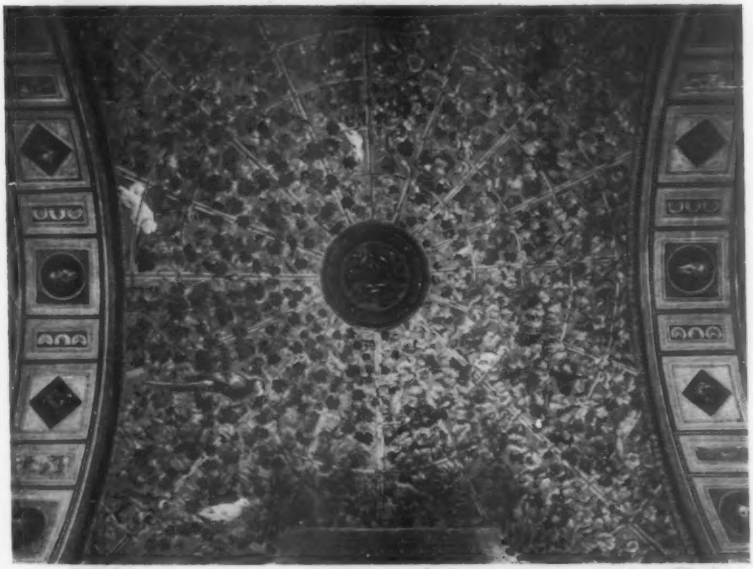


FIGURE 3c. Giovanni da Udine. *Loggia of Leo X, Vatican*

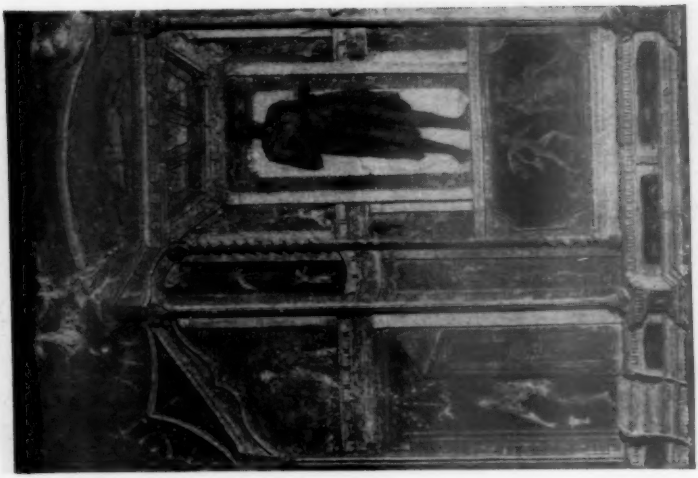


FIGURE 4b. *Decoration from Pompeii. Museo Nazionale, Naples*

FIGURE 4a. Veronese. *Fresco. Villa Barbaro, Maser*

FIGURE 5. Salviati. *Allegory in honour of Ranuccio Farnese. Palazzo Farnese, Rome*

FIGURE 6*a*. Sodoma. *The Family of Darius before Alexander. Villa Farnesina, Rome*

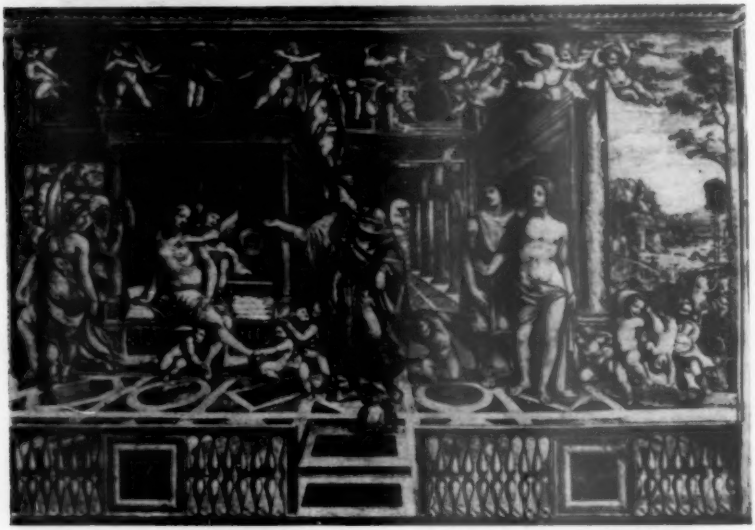


FIGURE 6*b*. Sodoma. *Alexander and Roxana. Villa Farnesina, Rome*

The use of a colonnade to break through a wall, as applied in the *Biblioteca Greca* or the *Sala delle Prospettive*, is common in second- and fourth-style Roman painting. In the House of the Vettii at Pompeii, for instance, not only does the colonnade produce exactly the same effect as in the Renaissance examples but it also shows the still-life elements which appeared in the *Biblioteca Greca* decorations (Figure 3*a*). The open cupboard door or window-shutter is again frequently to be found in Roman frescoes, for instance in the Villa of the Mysteries, and the cupboard filled with objects is a favourite theme of Roman paintings. The *velarium* spread over the middle of the ceiling is also a common arrangement, to be seen, for instance, in the Tomb of the Anicii on the via Latina, and a model for the trellis with birds and cupids is supplied by the fourth-century vault mosaic of Sta. Costanza (Figure 2*c*).[9] More surprising is the fact that the figure appearing through a doorway used by Veronese in the Villa Barbaro at Maser (Figure 4*a*) has exact parallels in ancient art. It is common to find on ancient sarcophagi a door ajar with a figure appearing through it,[10] but the device was also used in forms closer to Veronese, for instance in the decoration of the Stabian baths still *in situ* at Pompeii and in other similar panels now in the Naples Museum (Figure 4*b*). Even the idea of focusing the perspective of the illusionist decoration on the place occupied by the host may have an ancient origin. In certain Pompeian houses there is a point marked in the floor from which the architectural illusion is more complete than from any other point; further, this point is often not the geometrical centre of the room and must, therefore, have had some other significance, perhaps as the place from which the most important person connected with the room would normally view it.[11]

One important problem remains: How far did artists of the Renaissance know this type of Roman work? Almost all the examples quoted above were discovered long after the time of Raphael or Peruzzi and cannot have been the models which they had in mind, but there is indirect evidence which proves almost conclusively that these artists knew works of the same kind, and had indeed access to a very wide range of ancient Roman painting. The difficulty is that none of it survives. We know, for instance, that a great part of the Golden House of Nero was excavated in the early sixteenth century and was enthusiastically studied by artists of the time. But since then the decoration of the part excavated has disappeared almost without trace through fading caused by exposure to the air. On the other hand, the parts of the House which have been excavated in the last century show a wealth of painted decoration of all types, and it is fairly safe to assume that what is lost must have had some relation to what is now visible. So, for instance, we are entitled to conclude from a fragment recorded in photography[12] that panels must have existed with figures standing against colonnades in steep perspective, and that they probably suggested the use of this device to the author of the *Biblioteca Greca* frescoes and to Peruzzi. In certain cases a drawing of the sixteenth century records a relevant detail. There is, for instance, one by Giuliano da Sangallo after a wall decoration in the Bassian Basilica, which includes a series of open windows like those used by Borgognone and the *tarsia* designers. In other cases we can point to details in early sixteenth-century

works which are such exact copies of known types of ancient decoration that we are forced to assume that models, now lost, were available. The most convincing instance is the use of fourth-style architecture in the work of Amico Aspertini and in decoration by Raphael and his school.[13] The bathroom of Cardinal Bibbiena and the stucco decoration of the Villa Madama, for instance, include details which are precise reproductions of the Roman style (Figures 2*a* and *b*).

Another possibility is illustrated by the use of the *velarium*. A drawing by Francisco de Olanda made in the mid-sixteenth century records a ceiling from the Golden House in which a form of *velarium* appears in four panels round the central tondo. This evidence is enough to justify us in believing that other examples existed which may have been like the example from the tomb of the Anicii mentioned above as being the closest to Renaissance versions. In this case, however, there is another means by which the device may have been transmitted. Artists of the Renaissance seem often to have studied works which we should consider as clearly post-classical as if they, too, embodied the practices of ancient artists. In this case they might well have noticed that the use of the *velarium* as a vault decoration survived throughout the Middle Ages. The fifth-century mosaic on the vault of the Oratory of S. Giovanni Battista in the Lateran Baptistery is in fact entirely composed of a *velarium*, though so stylized as to be unrecognizable at first sight. The edge of the awning with the strings attaching is, however, quite distinguishable, though in the original it is made easier to see by the change of colour between the gold of the awning itself and the little strip of blue sky behind the strings. The *velarium* appears much more clearly, but on a smaller scale, at the top of the apse mosaic in the Cappella di Sta. Seconda e Sta. Rufina, also in the Baptistery, and in this form it survived for many centuries. It is to be found, for instance, in the twelfth-century apse mosaics of S. Clemente and Sta. Francesca Romana.

The mosaic in the Oratory of S. Giovanni Evangelista illustrates the use of fruit swags, which are often to be found in Roman art. In other mosaics, however, the swags are actually used as the architectural structure of the feigned ceiling, as occurs in the *Sala di Psiche* at the Farnesina. The closest example is to be found on the vault of S. Vitale, Ravenna, but the fifth-century mosaic in the Cappella di Sta. Matrona in S. Prisco, Capua, shows an interesting variant. Here the supports are palm trees, not swags, but the illusionist effect is increased by the fact that the ground is not gold but blue, suggesting the sky behind the curling tendrils of the vine. One may wonder whether Leonardo had some such model in mind when he designed the decoration of the *Sala delle Asse*. A similar use of blue ground is to be seen in the pendentive mosaics of the Baptistery of the Orthodox at Ravenna, and either this or a similar mosaic may well have been the model used by Giovanni da Udine for the white and blue stuccoed pendentives of the loggia in the Villa Madama.

It can also be proved that the Roman type of architectural illusionist wall painting was known through at any rate a great part of the Middle Ages. Architectural decorations very close in type to those at Boscoreale are to be

found in the mosaics in St. George, Salonika, and the Baptistery of the Orthodox at Ravenna of the fifth century, and in the ninth-century frescoes in S. Julian de los Prados at Oviedo.[14]

Moreover, there is one work of late medieval art which seems to prove that the principles of ancient illusionist decoration were never entirely forgotten. This is the great series of mosaics with which the dome of the Baptistery of Florence was decorated in the thirteenth century. The general scheme is astonishing at this date, for it is based on an assumption as bold as that of the great Baroque decorators, such as the Padre Pozzo, namely that the real cupola is removed and the structure of the building extended vertically to more than double its actual height. The tripartite division of the real walls by two orders of columns and pilasters is exactly continued through the four lower stages of the mosaic. The fourth zone is covered by a painted cornice which supports eight columns, one at each corner of the actual building, and sixteen angels, who walk in pairs between the columns. The top of this imaginary superstructure is covered by a *velarium* like those of ancient Roman ceilings, but misunderstood in that it forms cusps not only at the columns to which it is notionally attached but also at points midway between them where it has no support. The *velarium* is pierced in the centre by an opening, an arrangement which recalls the Pantheon, except for the actual shape of the opening.[15]

The illusionist devices are even continued on a minor scale in the lower part of the decoration. Between the real architecture of the substructure and the first zone of the imaginary superstructure is a band containing real openings which let in light from outside, alternating with painted frames enclosing half-length figures of bishops who, therefore, give the impression of standing in openings like the real ones between them. Below the arcade of the first story is another series of half-figures. In this case they fill each space and do not alternate with real openings, but their heads and halos break through the frames of the painted openings as if they were in real openings and protruded beyond them. The whole of this scheme shows an imaginative use of illusionism bolder than anything that was to be ventured for nearly two centuries. The effect is not as deceptive as many later schemes, but the vastness of the project is striking.

It seems, therefore, safe to assert that the highly ingenious *trompe l'oeil* effects evolved by fifteenth- and sixteenth-century Italian painters were in great part based on knowledge of ancient painting or of its principles as reflected in medieval art.

The artists of the generation after Raphael did not make any revolutionary innovations in illusionism, but they produced a great number of sophisticated variations on the methods of their predecessors. Before he was driven from Rome by the Sack of 1527, Giulio Romano painted the *Sala di Costantino* as a sequel to the Stanze of Raphael. In the decoration of this room he adopted a device used by his master in the *Sala di Psiche* at the Farnesina, but transferred it from the vault to the walls and showed the main subjects as if they were painted on tapestries hung from the cornice, as distinct from a *velarium* on the ceiling.[16] Between these feigned tapestries Giulio Romano placed colossal allegorical

figures, supposed to be seated on marble pedestals like the *ignudi* on the roof of the Sistine Chapel.

When, after the Sack, he settled in Mantua, he became even freer in his methods. The vault of the *Sala di Troia* in the Ducal Palace is painted to create the impression that the ceiling has been opened to the sky, and the episodes of the Trojan War are enacted by a series of figures who stand on the real cornice which marks off the wall from the vault. But Giulio's boldest invention is in the *Sala dei Giganti* in the Palazzo del Tè (Figure 1*a*). Here for the first time walls and vault are welded into a single whole; no architectural features define the lines along which they meet, and the transition from one to the other is rendered even more invisible by making the actual edges slightly rounded. Finally, the action spills down from the vault over all four walls. The vault, which represents Olympus, shows the gods sitting on clouds above which a great rotunda is supported magically in the air. On the principal axis of the room Jupiter is seen hurling the thunderbolts at the rebellious giants. The fate of the giants is depicted on the walls, where they are shown struck down by the wrath of Jupiter and crushed under the rocks and buildings which collapse under the shock of the thunderbolts. This is one of the most powerful, if not one of the most agreeable, illusionist effects ever attempted.

In Rome the style developed in a more restrained manner. About the middle of the century the loggia of the villa built by Julius III on the via Flaminia was decorated with an enchanting variant of Giovanni da Udine's trellis-frescoes in the lower loggie of the Vatican, a type of design which was to remain popular till the beginning of the seventeenth century, when it was used by Tassi in the Palazzo Rospigliosi.

More original were the variations produced by Salviati and Vasari on the methods suggested in the first decades of the century. In the *Salone* of the Palazzo Sacchetti Salviati uses the whole battery of illusionism to destroy the surface of the wall. A feigned Ionic colonnade forms the main basis of its structure, in front of which hangs a heavy frame enclosing the main subject, while the two subsidiary themes are represented on scrolls, like Chinese paintings, hung by ribbons from the capitals. From the bottom of these scrolls hang two smaller shield-shaped cloths painted with *imprese*, one of which—to extend the confusion—is balanced by the real marble shell-niche containing a real marble bust.

Salviati and others of his generation also carried further the breaking down of the demarcation between the real world of the rooms and the imaginary world of the painted decoration. In the *Sala di Costantino* Giulio Romano had depicted the Baptism of the Emperor in what is a fairly accurate version of the Lateran Baptistery, with the circular stepped central part cut in half, so that the spectator is almost drawn into the scene. In the *Sala dei Cento Giorni* of the Cancelleria Vasari takes this design a stage further by adding to the concave steps of Giulio Romano's design a second flight of convex steps which lead out into the room and give to someone standing in it the feeling that he could, if he wished, walk into the painting. This device is further developed in two frescoes

in the Oratorio di S. Giovanni Decollato. In Salviati's *Visitation* the bottom of the picture is formed by a parapet behind which is a flight of steps with figures walking up them. These figures are clearly in the imaginary world of the picture, but one of them stops to pick up a clock which comes out of this space into the real world of the chapel. In Pirro Ligorio's *Salome* in the same Oratory the effect is made even stronger by the removal of the parapet, so that no barrier exists between the two worlds of reality and illusion. The learned doctors, shown as half-figures in the foreground, seem to belong to both worlds, while the woman carrying a basket of fruit on her head has clearly just walked through the chapel and entered the fresco.

The interlocking of the real and imaginary worlds is given its most complex form in Salviati's frescoes in the *Salone* of the Palazzo Farnese (Figure 5). One wall is devoted to celebrating Ranuccio Farnese, the founder of the family fortunes. The left-hand scene shows him receiving the banner of the church from Eugenius IV, and on the right we see one of his victories. In the middle he is depicted seated and triumphing over his conquered enemies. Above him hangs a feigned tapestry of Venus at the forge of Vulcan fetching the arms for her son Aeneas. The arms are carried off by putti, one of whom, holding the spear, flies right out of the world of the tapestry to hand the spear to the figure seated below in the world of the fresco. This interpenetration of two worlds of first and second degrees of illusion is even more alembicated than the confusion shown in the Farnesina between the real and the imaginary. The confusion also serves to convey the idea that Ranuccio Farnese is identified with Aeneas and enjoys the special favour of the goddess. Mannerist ideas of wit could hardly have a clearer illustration.

The end of the sixteenth century did not produce any basically new developments in the history of illusionism, except in Northern Italy where the great inventions of Paul Veronese, particularly in the decoration of the Villa Barbaro at Maser, opened up altogether new fields, which are, however, outside the scope of this lecture. In Rome the members of the Alberti family showed great ingenuity in their use of foreshortened effects of architecture,[17] but fundamentally they were only adapting and extending the methods used by Mantegna in the ceiling of the *Camera degli Sposi*. Only in their last major work, the *Sala Clementina* of the Vatican, decorated for Clement VIII (1594–1601), did they create new effects by lifting the whole vaulting off a room of vast dimensions and opening it up to architectural extension and the sky beyond. In this way they prepared the way for the great achievements of the late Baroque, such as Padre Pozzo's decoration of the vault in S. Ignazio. But with this, and with Pietro da Cortona's ceiling in the Palazzo Barberini, we are in another world, a world which made use of what had been discovered in the sixteenth century, but applied it to different ends. The development of Baroque illusionism is, therefore, another, though equally curious, story.

NOTES

1. In his *Last Supper* in S. Apollonia he uses even more ingenious types of illusion.
2. Pinturicchio also uses ingenious deceptions in the della Rovere Chapel in S. Maria del Popolo, Rome.
3. Cf. Vasari, *Vite*, transl. by de Vere, London, 1912–15, IV, p. 222.

4. This decoration is now very much restored, but the basic principle of the scheme has been preserved. Fragments of the wall frescoes have now been discovered and indicate that the trees sprang from an elaborately designed zone of rocks, roots and earth (cf. J. Gandtner, *Gazette des Beaux-Arts*, 1959, i, pp. 27 ff.).
5. On the Biblioteca Greca and the Palazzo Venezia frescoes, cf K. Lanckoronska, *Jahrbuch der Kunsthistorischen Sammlungen in Wien*, N.F. ix, pp. 111 ff., and Hermanin, *Dedalo*, xi, 2, 1930, p. 457.
6. The frescoes bear the date (restored) 1487. Cf. J. S. Ackermann, *The Cortile del Belvedere*, Rome, 1954, pp. 6–8. In the latest restoration the parts which are wholly new have been made clearly distinguishable from the surviving parts of the earlier decoration. Doubts have been expressed whether even these fragments date from the fifteenth century, and it must be admitted that they do not altogether agree with Vasari's statement that the landscapes represented the great towns of Italy. On the other hand, this description at least proves that the decoration consisted of landscape views, in itself a great rarity at this date. Another example of landscape decoration between pilasters is to be found in the loggia of the House of Cardinal Bessarion on the via Appia. It is heavily restored, but the decoration probably dates basically from the time of Cardinal G. B. Zeno, who owned the house from 1479 to 1501 (cf. P. Tomei, *L'architettura a Roma nel Quattrocento, Rome*, 1942, pp. 92 ff., and D. Biolchi, *La Casina del Cardinale Bessarione*, Rome, 1954).
7. It is possible that the balustrade may have been inserted when the room was completed by the painting of the left-hand wall, apparently in the middle of the sixteenth century, but in view of the tricks played by Sodoma in the right-hand wall there does not seem to be any need to assume that this is the case.
8. Here again one might suppose that the lower part of the fresco was a later insertion, but it is particularly mentioned by Vasari as being part of Sodoma's work at the Farnesina (cf. *Vite*, transl. de Vere, London, 1912–15, vii, p. 249).
9. A similar vine design was recorded in a seventeenth-century engraving by P. S. Bartoli after a tomb in the Villa Corsini.
10. One, for instance, has stood since early times outside the Baptistery at Florence.
11. Cf. John White, *Perspective in ancient drawing and painting*, London, 1956, pp. 72 f.
12. Though even this fragment has now disappeared through fading.
13. These connections have already been pointed out by I. Bergström in his 'Revival of antique illusionist wall-painting in Renaissance art', *Göteborgs Universitets Årsskrift*, lxiii, 1957, pp. 27 ff.
14. I am indebted to Professor Francis Wormald for calling my attention to the last example.
15. The upper part of this decoration may derive from the dome mosaic of S. Costanza, destroyed in the seventeenth century, but known from drawings and engravings.
16. He probably also had in mind the tapestries after Raphael's designs which hung round the lower part of the walls of the Sistine Chapel.
17. In S. Silvestro al Quirinale, the Aldobrandini Chapel in S. Maria sopra Minerva, and the Sacristy of S. Giovanni in Laterano.

THE CHAIRMAN: Faced with the problem of making comment on a learned and original lecture, it is sometimes wise to fall back on a device of childhood, and ask 'Why?'. One always supposed that the feeling of uncertainty which came over Roman civilization after the sack of Rome would explain any ambiguities, any passion for ambiguity which is found in art; but a much more puzzling question is how in the age of Raphael, how in the seat of truth (which I suppose I must call Rome), how at a time of the greatest confidence, when Raphael was producing a style, as in the *Stanze*, so extremely lucid and so lacking in ambiguity—why painters at the same time did this. I think the only explanation, which Professor Blunt implied, was that they were dependent for their style on antiquity, and as they discovered that antiquity had indulged in these tricks, so they imitated them too.

It has occurred to me to wonder whether there is not a secondary exlpanation also; for at that time there was this great preoccupation with the idea of the *Paragone* as to whether painting was superior to sculpture, or sculpture superior to painting; and in an almost insane attempt and desire to show that painting could do so much more than sculpture or anything else, the painters, contrary to what would have been really their own proper style, explored these curious devices. That, however, is merely a slightly reckless suggestion.

Since there are no questions, I should now like to propose a vote of thanks to Professor Blunt for a most stimulating—an admirable—lecture.

The vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman upon the proposal of Brigadier J. L. P. Macnair, the meeting then ended.

THE MECHANIZATION OF BUILDING CONSTRUCTIONAL PROCESSES

The Alfred Bossom Lecture by

D. G. R. BONNELL, Ph.D.,

Deputy Chief Scientific Officer, Building Research Station, D.S.I.R., delivered to the Society on Wednesday, 4th February, 1959, with Sir Alfred Bossom, Bt., LL.D., F.R.I.B.A., J.P., M.P., Chairman of Council of the Society, in the Chair

THE CHAIRMAN: We have a very interesting subject before us this afternoon, and I am sure that we shall learn much from Dr. Bonnell's paper. Everything we do is in some way connected with building, and mechanization must be taken in hand if we are to finish our buildings as quickly and economically as possible, in order to meet competition from other countries, for we all live and work in some way, and the cost of the buildings adds either to our individual cost of living or to the cost of all items manufactured inside a permanent structure.

The following lecture, which was illustrated with lantern slides, was then delivered.

THE LECTURE

This is a time when 'automation' is one of the O.K. words, and it is thus perhaps not very unexpected that the Bossom lecture of this august Society should deal with the mechanization of building constructional processes. Furthermore, it is very fitting that Sir Alfred Bossom, who for many years has been actively associated with the Building Industry in this and other countries, should himself take the Chair.

Man has from prehistoric times been exercised with the problem of making machines do his work for him. The result has been a gradual widening of work covered by machines and a steady recession in the need for hard and heavy physical work by man himself, until to-day we have the near-human products of the electronic age.

We see new industries develop in which mechanization is the main key to efficiency, and presumably things will continue to travel along this road until we reach complete automation in some suitable industries. But what of one of the oldest of man-made industries—building? In recent years this industry has been the target of many accusations, one of which is that it lacks efficiency consequent upon the fact that it is not making full use, some would say any use, of the mechanical machine which has proved so advantageous in increasing efficiency in other industries. Given such a pervading atmosphere, it is very typical of this Society to want to review the position regarding the mechanization of building constructional processes.

First, it is advisable to build up a picture of the industry involved. The building

and civil engineering industry—and it is very difficult properly to separate these two—employs about 1,500,000 persons, of whom about 75 per cent are employed by contractors and about 25 per cent by public authorities. The total value of the work carried out annually in the industry is around £2,000 million, of which about two-thirds is in respect of new work and the remainder is spent on repairs and maintenance. The work done by the industry itself represents about 6 per cent of the national income, and about half the fixed capital investment of the country consists of building and civil engineering work.

Of the £1,400 million spent on new work, just over four-fifths is for building and just under one-fifth for civil engineering work. Again, of the building work, one half or about £600 million is for new two-storey housing, while the other half covers industrial and commercial buildings, schools, hospitals and universities. This division of work is important when considering the application of mechanization to building operations.

There are about 100,000 registered building firms in this country, but of these only about 3,800 employ more than 50 operatives and fewer than 100 firms employ over 1,000 operatives. We have thus a very large industry obviously broken up into a large number of firms doing a wide variety of work.

Another aspect which must be considered is the conditions controlling the final product. Frequently this product is designed completely out of contact with the actual producer, whereas, normally, in most industries design and production are under a unified control. Again, the product remains where it is produced and the labour and plant have to be brought to it, while in addition it is exposed to the vagaries of the weather during construction. Also, the construction work only covers about 45 per cent of the total cost, the remaining 55 per cent being the cost of materials supplied by a variety of industries which are not, in all cases, wholly dependent on the building industry for their market.

In fact, it is not unreasonable to look upon the building and civil engineering industry as the assembly half of a building-materials and construction industry. In other assembly industries, as for instance the motor car industry, it is possible to mechanize an assembly line, inasmuch as the already assembled parts can be made mobile and the final products move off the end of the line. The consequence is that the work involved in the manufacture can be planned in detail, and the environment conducive to the highest productivity provided, in the knowledge that the arrangements made will apply for a reasonably long production run. This is not possible with the building industry. Here, even if sufficient repetition is obtained within the building area, which is rarely the case, the individual parts must be brought together for assembly at one fixed spot, and thus the mechanization possible with a mobile product is not attainable. In addition to all this one must realize that a number of craft processes are involved which are carried out *in situ*; a further complication being that many of these are *wet processes* involving time as a factor in their use, while the weather conditions in which the work will be done are completely beyond the control of the builder.

Building is a traditional industry, and the methods and procedures used have

been developed and modified as each generation benefited from its fathers. Some of the construction methods used have, therefore, their roots firmly planted in tradition which, if it is allowed to take control, tends to slow down progress. In these circumstances is it any real cause for wonder if we find that the building trade is not quite so ready to adopt new procedures as, shall we say, an industry which is based on a recent development of knowledge? Apart from the above-mentioned differences between the building industry and some of the well-known manufacturing industries there is one further, and perhaps vital, factor. If a client buys a dud wireless set, he returns it to the manufacturers and gets another in exchange, but if a client gets a dud building it is obviously not possible for the contractor to take that back and give him another instead. Furthermore, the final product is there for all the world to see, and its defects are soon noted, to the detriment of all those concerned with its design and construction.

It is in this general climate that one must review the mechanization of constructional processes.

THE PROCESSES

The normal processes involved in building construction may be divided very broadly into two categories, namely, the craft processes and the servicing processes.

The crafts involved are carpentry and joinery, bricklaying or masonry, plastering, plumbing and decorating. What has the machine done for these crafts?

In the joinery shop it has replaced most of the hand tools with mechanical tools capable of planing, cutting, moulding, etc., much more accurately than the individual craftsman could do. It has enabled a large number of joinery units to be mass-produced in the factory with a degree of precision which was not readily obtained before. It has also provided a number of powered hand tools for the site work. Electric woodworking tools such as saws, housers, routers, mortisers, and for planing, are now available to assist the craftsman. Although this change may make some look back with nostalgia on the old days when the hand-craft flourished, I think one can be assured that these new methods have come to stay. The machine has, however, done little or nothing for the bricklayer or mason, for although many devices have been made to assist in this work, the contribution has been negligible.

In plumbing, the machine is now assisting by making preformed units which need little more than assembly on the building site. This development is likely to accelerate in the near future, so that certain parts, at least, of the old craft will disappear from the building site.

Decorating, however, is another craft which has been little assisted by machines and, in the main, the painter is carrying out his work to-day very much as he did fifty years ago. Considerable success has attended the development of rollers, which enable large areas to be covered more rapidly than with brushes, and paint-spraying has now become an accepted technique. The machine has, however, assisted the paint manufacturing side, for it has greatly facilitated the placing of a wide variety of different paints and other materials at the decorator's disposal.

For plastering many attempts have been made to provide a mechanical device for applying cement and plaster, but up to the present only partial success has been obtained with some external renderings. At the Building Research Station we have examined a number of machines, manufactured either on the Continent or in America, for carrying out internal plastering, but none has been really satisfactory. It is worthy of note, however, that this problem is exercising the minds of some manufacturers, and the day may not be far distant when a successful machine will be developed.

The engineering services, such as electrical services, heating and ventilation, might perhaps be mentioned here. In these the machine has played a predominant part, particularly in the design of installations. Appliances such as lifts, mechanical stokers, motors, fans and so on are an integral part of to-day's engineering services.

The effect of the machine on the crafts is thus variable, gradually replacing operations in some, while making very little impact in others. What is the position in the second broad category, the servicing processes? Here the situation is different and a change is apparent to all who knew the industry, say, twenty years ago.

On any building project, whether it be constructed with the traditional bricks, mortar and timber, or with the comparatively newer material, concrete, reinforced or prestressed, a vast quantity of material has to be moved about and placed in position. The magnitude of this work may be assessed from the fact

FIGURE 1. *A 10-cu.-ft. dumper*

that there are, for instance, nearly 300 tons of material in a pair of semi-detached houses. Some of this material is often moved two or three times before it reaches its final position in the building. In spite of this, before the war one rarely saw, on the site of a traditional brick or masonry building, any more plant than a wheelbarrow, a mortar or concrete mixer, a hoist and—on large buildings, mainly steel-framed—a derrick crane. Materials were commonly carried vertically by hod or mortar board and horizontally by wheelbarrow. This position is gradually changing—the powered barrow (Figure 1) is being used much more widely for moving materials over the building site, while on an extensive site the monorail transporter is frequently seen, particularly for moving concrete for foundations. This simple change alone has been of considerable advantage in increasing productivity.

Hoists have been in use over the past 30 years, but before the war they lacked the mobility required for, say, housing sites. This weakness has now been overcome and there are a number of hoists available which are easy to erect, dismantle and move from one position to another. Also, elevators have been developed for a similar purpose. These latter are particularly useful when internal scaffolding is employed, since they can be used to lift the materials through openings on to the scaffold platform.

In the excavation of foundation and drainage trenches it is now practicable even on the smallest sites to do the work economically by machine. This has been made possible by the introduction of excavating attachments suitable for fitting to standard agricultural tractors. Figure 2 is an example typical of several machines now available on the market. The operating cost of these small excavators is low because they are relatively cheap in first cost, can travel by road under their own power and can easily be removed from the tractor, thus freeing it for other work when necessary. On large sites the heavier excavators and trenchers are more economical on account of their high operating rates, which can amount to as much as 40 cu. yds. per hour. The hire rates, fuel consumption and road haulage charges are, however, correspondingly high, and their use is unlikely to be economical unless continuously employed for the whole of the hire period.

It is clear therefore that where traditional forms of construction are employed, even in cases where the volume of work involved on the site is small, assistance can now be obtained from the use of mechanical plant.

Passing on to larger buildings, using the less traditional concrete construction, we find that the machine can play an even bigger part.

Commencing at the mixer end, it is now possible to mechanize a considerable amount of the hard manual work required for moving the aggregates. The old method whereby the aggregates were laboriously shovelled into the skip and the cement supplied in bags is now fast disappearing. The aggregates are moved into the mixer, or into hoppers above it, by a drag scraper attached to a small winch on the mixer; the cement is delivered in bulk and on the site it is unloaded by compressed air into a silo which is fitted with its own weighing device. The aggregates are automatically weighed in the hopper-weighing mechanism and

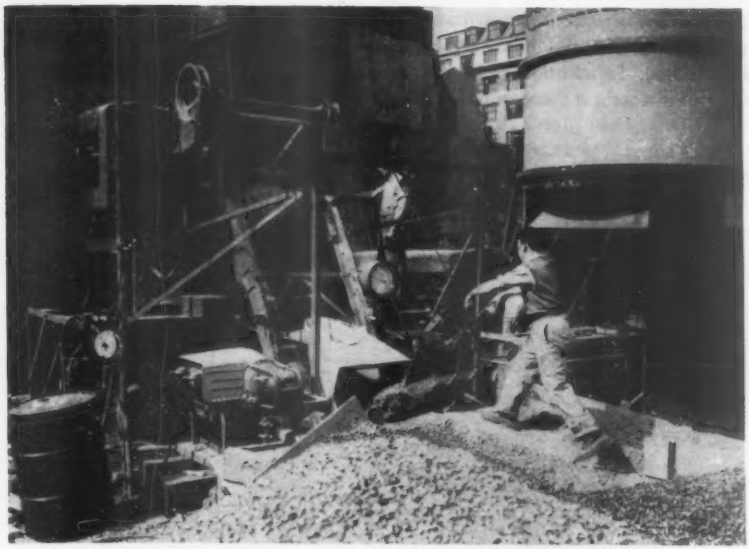
FIGURE 2. *A hydraulic digger with its open-sided bucket mounted on an agricultural tractor*

thence pass to the mixer. With this arrangement (Figure 3) only two men need be permanently employed with a mixer of 10 cu. ft. capacity. A few years ago it would not have been unusual to see 10 or 11 men working around such a mixer. The mixing station on a sufficiently big building becomes, in effect, a mechanized factory. In fact, it is not now uncommon for the concrete to be made in a factory and delivered ready for placing at the site. This practice is likely to increase during the next few years, particularly if mechanical devices can be made to assist in taking the concrete direct from the delivery container to the actual placing point.

When the concrete has been placed, powered floats can now displace the hand float finishing.

All the materials required for the building, whether concrete, bricks or steel, are usually delivered or prepared at ground level and must be carried by some means or other to the placing point. Probably the most useful of all handling appliances is the crane in one or other of its several forms, because of its unique characteristics as a transporting vehicle.

The mobile or tower crane as developed on the Continent is, however, a comparative newcomer to this country, the first of its kind having been imported by the Building Research Station in 1950. Similar cranes had then been in widespread use in France and Germany for more than 20 years. I think the first



[*By courtesy of A.C.E. Machinery, Ltd.*

FIGURE 3. *Arrangement of 10-cu.-ft. concrete mixer with weighing hopper; the aggregates handled by drag scraper, and cement in bulk*

recorded use in France of a tower crane for building purposes was described in an article in the *Builder* of 16th January, 1858. This machine was powered by steam and, as a result of the mechanization introduced on that particular site, a saving in labour of 65 per cent was claimed. Curiously, tower cranes had never been adopted in Great Britain. To-day, however, there are many hundreds in use throughout the country and the crane has become a well-established item of plant and a familiar sight in most big towns and cities. It is of passing interest to note that, as far as I am aware, it is still not being used in the U.S.A.

These cranes are characterized by a high tower with a long jib able to slew through 360°, and are electrically driven self-propelled machines running on rails. A typical tower crane is shown in Figure 4. By virtue of its height, long reach and mobility, it is possible through one machine to cover a building site with a means of vertical and horizontal transport.

As compared with the power-driven hoist, which, as I said, has been used in this country for over thirty years, tower cranes have certain distinct advantages. Firstly, loads may be transferred in one operation from stock pile, production point or delivery vehicle practically to their destination on the building. Secondly, the size of the handling team is reduced and its composition is not appreciably affected by the type of load being moved. Lastly, considerably greater loads in both weight and size can be handled. This is particularly noticeable when dealing

with concrete shuttering. This can now be prefabricated on the ground in units which are easily assembled, without being too severely limited as to size. In fact, units of formwork extending the length of the component to be cast can readily be handled. In addition the crane can not only hoist the unit into position, but can maintain it there until the necessary fixing is complete.

FIGURE 4. *Tower crane on the site of a six-storey block of flats of reinforced concrete construction. Central mixing station with overhead aggregate hoppers and weigh-batching plants can be seen on the right*

The tall buildings which are now going up in our city centres have, however, introduced new handling problems. Mobile tower cranes of the types already mentioned can be used to very good effect up to building heights of about 100 ft., but in excess of this it becomes increasingly difficult to utilize the travelling motion on a crane of economic size. A recent development fortunately presents an alternative method of use which is of particular interest. The 'Climbing Crane', originally developed in Russia and Sweden, and now being adopted by other countries on the Continent, has recently been introduced here for use on high buildings, as shown in Figure 5. Like its forerunner, the mobile tower

crane, the first climbing crane was brought into this country, in 1956, by the Building Research Station. This type of crane has a short fixed tower but in many other respects is similar to a mobile tower crane. The crane is first erected as a fixed crane to a height of about 50 ft. by securing it to a prepared base inside the building. As the building grows in height, and the floors are installed, holes are left for the passage of the tower, and at a suitable height two guide collars embracing the tower are mounted on adjacent floors. The whole crane is then raised by means of a winch and fixed to the collars at a higher position. The climbing process is repeated every two or three floors and the ultimate height it can serve is only limited by the amount of rope that can be wound on to the hoist drum.

FIGURE 5. *A typical arrangement for a climbing crane*

The use of the crane in this way naturally involves the structural designer, because all its loads, including both lateral and vertical forces, are transmitted to the building. If weights greater than about 30 cwt. are likely to be handled by the crane, special provision may have to be made in the design to withstand the loads transmitted in this way to the structure. A notable advantage of this type of crane is that since it is located within the building the fullest use can be made of the reach of the jib. This is well illustrated in Figure 5. All the movements are remotely controlled by means of push buttons on the end of a wandering lead. This enables the operator to move about and keep the load constantly in view, thus facilitating accurate placing of the material. Since 1956 about seventy climbing cranes have been acquired by the industry as a whole. They

have been found particularly useful for buildings over about ten storeys in height as well as on congested sites where it is impracticable to use a mobile crane. Although not so versatile as a mobile tower crane, the climbing crane when used for high buildings is, in comparison, much cheaper in first cost. There are cranes available which can be used either as mobile or as climbing versions.

For the best deployment of a crane the method of building construction should require a high usage rate, with loads equated as nearly as possible to the crane's capacity. The degree of success achieved towards this end will depend largely on the design of the building. In this connection it is not always appreciated by designers that the time taken to handle and erect components with the aid of mechanical plant is more nearly proportional to their number than to their size and weight.

The crane can perform many of the functions previously carried out by manual labour: for example, as previously mentioned, the lifting and positioning of prefabricated formwork preparatory to its being lined up and fixed by craftsmen. It will subsequently lift and place the concrete in the formwork and also place in position any precast units such as beams or floor slabs. In addition to these larger units there are also a variety of small units required for cladding the walls and for partitions, all of which have to be unloaded from vehicles and transferred to the building at various stages; often via a stockpile. For instance, few buildings are erected which do not contain bricks or dense or light-weight concrete blocks, and in the past these have been delivered loose on lorries and laboriously unloaded by hand on the site. This work invariably withdraws labour from other productive operations and can have a disruptive influence on the smooth working of the building team.

In order to reduce the labour expended on handling these small units, which at its best is a heavy and tedious task, the Building Research Station has developed a system of handling bricks or blocks in packaged form. Bricks are formed in special jigs into packs of 50 at the brickworks and bound with a single steel band, by which the pack may be lifted with the aid of special equipment. During their transport from the kiln to the bricklayer the bricks remain in packaged form throughout. On the site a special barrow is used for horizontal movement of the packs and also for unloading lorries with a simple ramp. When a crane is available, four or eight packs at a time can be transferred from the delivery vehicle direct to the point of use. A special four-pack lifter has been developed for this purpose—the packs being lifted by their bands and enclosed by a counter-balanced safety cage. The introduction of this system has led to bricks being handled much faster on sites, and to the simplification of site organization, particularly on the congested sites so often found in the centre of our towns and cities.

The development of multi-purpose machines such as cranes leads designers to explore the possibilities of using much larger units than has been traditional. Until now, building construction has meant assembling together an incredibly large number of fairly small units in conjunction with what may be termed *in situ* craft work. Considerable thought is now being given to making large units of several tons in weight. This has been pursued with greater vigour in

France, Sweden and particularly Russia in the last two or three years than in other countries. In this country perhaps the most well-known system is that devised by Reema Construction Ltd., in which the external walls and main partitions are built with precast panels of varying weight up to a maximum of two tons. In France the Camus and Coignet systems have gone far towards a fully mechanized factory production and site assembly. The wall units are of room size and are again of varying weight up to four tons. Figure 6 shows a block of four-storey flats at different stages of construction. In many of these Continental methods a mobile Portal crane is used which straddles the block being built and consequently facilitates easy positioning of the components.

Russia has, however, probably more than any other country in Europe, developed this form of construction. Large units of many tons in weight are factory made and assembled. This policy appears to have been deliberately adopted, and therefore this method of building is likely to progress more rapidly in Russia than in other European countries.

FIGURE 6. *Various stages in building in heavy units (from France)*

SUMMARY OF PRESENT POSITION

Let us now try to summarize the present position. Building construction is carried out fully exposed to the vagaries of the weather. Each part of the building, however small, has to be transported to a fixed position. The building may well cover a high proportion of the site, and the amount of storage space for materials and components may be small. At the other extreme the building operations can be dispersed over a wide area with low concentration of work over any specific part.

Again, when work is carried out at varying levels above ground, the planned sequence of operations and their execution becomes more complex. A variety of materials has to be supplied intermittently over a scattered area, and their movement must be in both horizontal and vertical planes. With increasing height the time-cycle for moving materials lengthens. Still further complications can, of course, arise when the main contractor is only executing a part of the work, the remainder being carried out by sub-contractors.

Although superficially all buildings appear to present the same constructional problems, there is a sufficient difference between them to force the contractor to consider each contract as a 'one off' job. This is not unexpected when one considers that designers consciously avoid repetition in design; and even apart from this, designers have no information as to the capabilities or experience of the contractor who will ultimately construct, or of the facilities he may have for dealing with the problems posed by the design.

These are circumstances which are not conducive to high mechanization. It must also be kept in mind, as I mentioned before, that the contractor only controls about half the cost of the building. Therefore when considering the capital investment in special equipment the contractor has to take account of the uses which can be made of a particular piece of plant. For instance, the speed and capacities of the machines most suited to serve craft processes would often be quite inadequate in dealing with operations in concrete construction. Nor does it follow that the most suitable plant for one contract will necessarily be the most suitable for another. Again, in view of the intermittency of the operations, a high proportion of the time in which the plant is on site may well be idle and unproductive as far as the plant is concerned. Overshadowing all this, of course, is the influence of tradition on the design and construction side as well as on the user side.

However, in spite of all these limitations and unfavourable conditions, one can say that progress is being made in substituting mechanical plant for human sweat and tears or, in current phraseology, in industrializing building construction. Over the last ten years the machine has considerably affected the whole organization of the building contractor. It has removed a significant proportion of the heavy manual work. It has provided means of transporting materials quickly from delivery point to final position. It has also emphasized the need of higher quality organization on building sites, but to some extent it has also considerably facilitated the implementation of good organization. The selection

of the most efficient method for the use of plant on any contract really involves a comparison between the costs of different methods of executing the work. The cost of mechanized operations is largely influenced by two factors: first, the sequence of work imposed by the design of the building and the methods of construction used by the contractor, and, secondly, the quantity of work to be done and its concentration in space and time. Thus the efficiency of mechanized systems cannot truly be judged by consideration of the unit cost of any single operation; it must be assessed in terms of its effect on the total cost of all the operations involved. Comparison of two or more systems consequently can only be made by assessment in turn of the cost of groups of operations as performed by each alternative. This implies the preparation, in outline at least, of separate programmes from which an appraisal can be made of the labour and plant cost required by each system This does not differ appreciably from the procedure adopted by a planning engineer in an engineering works when he is preparing a programme for a production run. Unfortunately in building the path is beset with more difficulties and the programme must be considerably more flexible to allow for eventualities such as bad weather holding up certain operations, sub-contractors defaulting on their time schedule, or local shortage of essential labour or materials, among many others.

The degree of mechanization of building constructional processes which has been achieved may not be great; it is certainly not enough for those of us who are impatient for a higher rate of application; but a close examination of the position shows considerable acceleration over the last few years, indicating that the industry is developing an awareness of the potential value of utilizing the facilities offered by this mechanical age.

Such is the present position, but surely a fair question is 'Quo vadis?' As we have seen, it is unlikely that we can expect to mechanize the crafts to a much greater extent. We can undoubtedly progress farther with what I have called the servicing processes. For this it would appear necessary for the designer to have a greater appreciation of the possibilities of the machine. Obviously some designs are more likely to use the potential of the machine than others in that, for instance, they allow more repetition of operations or facilitate a more concentrated use of mechanical plant; lack of continuity of work tends to militate against mechanization. In most building operations a steady flow of work can be more easily obtained when operations are simple and repetitive. It is worth mentioning too that the non-productive time taken up at the start and finish of an operation is little affected by its size, and therefore the ideal plan is to make each production run as big as possible, with the minimum of interruption. These aims can only be reached when designers are aware of the machine potential.

Is this all that we can expect? I have mentioned that the availability of suitable machines has led some designers seriously to think whether the traditional methods of construction are the most suitable and economic in the circumstances. The present climate must surely stimulate us to ask a variety of questions. For instance, is the present structure of the industry, with its 100,000 builders

on the construction side, and 20,000 architects on the design side, the most suitable for this machine age? Should we stick to the complete separation of the two sides of the industry; and, if the answer is in the affirmative, is there a price which must be paid?

Are we bogged down too much by tradition in our thinking about building construction? Should we proceed towards making the contractor's work pure assembly; eliminating the traditional crafts and introducing completely new skills? This is what has happened in many manufacturing industries where skilled fitting has been replaced by the assembly of interchangeable parts, machined to defined limits. This change called for complete rethinking in terms of simplification of the operations and standardization of the components. Is this the path that the building industry should tread? I will not attempt to answer these questions, although possibly the replies to some of them cannot be long delayed. The very fact, however, that these questions arise in our minds now is to some degree a measure of the influence which mechanization has already exercised on building constructional processes.

DISCUSSION

THE CHAIRMAN: I wonder whether Dr. Bonnell would tell us whether it is better to assemble more of the larger units before they come to the site, and in consequence have more of the necessary mechanization done in a factory?

THE LECTURER: It is a wonderful thought, to transfer a large number of the operations, which traditionally have been carried out on the site, into the more congenial atmosphere of the factory. We did try this immediately after the war—a number of large factories were available, and it was hoped to be able to use those in order to augment the housing that we required. One of the factors which made it uneconomical, once the traditional building industry had been geared up to its pre-war level, was the cost of transport.

MR. P. K. SHAHANI: I believe some years ago the lecturer made certain investigations into an apparatus for measuring small changes in linear dimensions. I wonder if there has been any further investigation into it and whether it would be of any significant help to the mechanization of building construction processes?

THE LECTURER: Although information of the small linear changes which occur with some building contributes to our knowledge of the behaviour of the whole building structure and helps us to avoid the development of certain defects in the completed buildings, it does not, I think, give any help in the mechanization of the operation.

MR. FRANK H. HEAVEN, A.R.I.B.A., A.R.I.C.S.: One illustration that struck me very forcibly was the Russian one, showing large units of walls and floors. Does the lecturer know whether it is necessary to strengthen those units beyond an economic limit in which they could be erected by hand?

THE LECTURER: I do not think so. It depends on the design more than anything else. I do not think it is necessary to make the unit heavier and stronger than it would be if it were constructed *in situ*.

MR. D. O. MAY, M.I.O.B.: In factory work generally, mechanization gives us great accuracy, but I must say that mechanization in the building industry has destroyed all that to the point where nobody cares, for example, whether a building is three inches out of the vertical.

THE LECTURER: You never want anything to be more accurate than the situation

demands, and in building, accuracy as we know it, shall I say mathematically, is not a thing which has troubled builders. Accuracy of dimensions is, however, important when you are assembling large components. If once you decide that the industry should travel along that path then much more attention must be paid to dimensional accuracy. In the building industry what happens traditionally is that the following trade always hides the deficiencies of the previous one. If this room was an inch out of plumb I do not suppose any one here would notice it. But on the other hand, if you have manufactured your components with fine tolerances and want everything to fit, then ordinary engineering practice should apply and you must have the greater accuracy.

MR. V. SIMPSON: The speaker has compared the methods of the building industry with the methods of production used in the manufacturing industries. Would it help the building industry if the goods that we produced were not made to last so long as they are? To compare with manufactured goods: a motor car coming off the line probably only lasts ten years at most, whereas a building is built to last forever. Could we have some defined ratio of the life of a building?

THE LECTURER: Immediately after the war the question of a building's life became an important factor in relation to housing subsidies. If you use the traditional material, your building cannot help but have a fairly long life. Whether it is possible to revise the general approach to building is something that I cannot attempt to answer. Most of the people in this room, asked to accept a house with an outside metal cladding of the thickness used for motor cars, would undoubtedly opt to buy one built of the more traditional materials. If we are prepared to change our attitude towards building then it may well be possible to construct a building with a useful life of only ten years rather than sixty.

MR. A. POWIS BALE: Would Dr. Bonnell advocate any modifications for builders in the Commonwealth (Western Australia, for instance, where I had a good deal of experience), for dealing with the problem of long distances? Prefabrication is quite impracticable, but there must be other ways of adapting our standards for a territory like Western Australia, where the towns are few and far between.

It seems to me that the value of a lecture of this sort is chiefly to the small man who has not got much money to spend, and who has got to turn out an efficient and cheap product at a low price with the aid of very little plant. The Building Research Station, of course, does help such a man considerably. Would Dr. Bonnell agree that it is just as desirable for the small man to make a plan or diagram of his site and the position of the roads, so that he can avoid that waste caused by having his material dumped here, there and everywhere, and having to use zigzag routes whenever he wants to get at his material? I have encountered much of this kind of waste when I have been designing the plants for making windows, doors and such like. Though you can get many joinery works which are first-rate from the machine tool point of view, they are very bad from the way goods are handled, stored, and moved.

THE LECTURER: I heartily agree that good organization is necessary, whether a builder has a small or large firm.

MR. J. LLOYD OWEN, M.A., B.SC.: It is interesting to recall that the pioneer efficiency expert, Gilbreth, began life as a bricklayer. He became champion bricklayer of the U.S.A. and managed to double the rate of laying bricks. If he were alive to-day, with all the mechanical aids we have now, would his mind not turn to the design, shape, and weight of the brick? Would he not conclude that the brick, as we know it to-day, is in fact the result of very primitive ergonomics? Would he not be tempted to say that, with all these mechanical aids, we should change the shape of the brick and possibly double its weight? I am thinking of a conveyor belt feeding bricks to a

bricklayer in the way that goods are fed to a packing station in a factory. The dimensional ratios of a brick were designed for the human hand; they need to be designed for mechanical conveyors.

Ten years ago we sent a Productivity mission to America to investigate methods there, and the report stated (this was in 1949) that they were making great use of premixed concrete, mixing their concrete in the lorries and wetting it only on arrival at the site. They were also making great use of power tools for carpenters, joiners, plasterers, etc. Would the lecturer kindly tell us, ten years after, what progress we in the United Kingdom have made in these matters?

THE LECTURER: Gilbreth's ideas were undoubtedly in advance of the time. I cannot say whether he would still be in advance of the time if he were alive to-day. There is no doubt, however, that the trend of thought at the present time is towards larger building units because, instead of manual handling, we now have mechanical handling, and therefore size is not so difficult to deal with as it was.

The ready mixed concrete industry is well founded in this country, and it is considerably increasing its output at the present time. On quite a number of jobs in and around London you see the ready mixed concrete trucks delivering concrete to sites. The problem that has to be solved is to increase the radius of delivery from the container on the job. At present that radius is comparatively small, therefore the ready mixed concrete often has to be rehandled as soon as it is delivered. What we are trying to do is to see whether we could not multiply that radius by five, six and possibly ten, so that when the container comes on to the site the concrete can be delivered over a much bigger and wider area.

It is very common now for joiners and carpenters to use power tools, but it is doubtful whether you could design any power tools to help bricklayers. There has been considerable development in handling-tools in this country since the war. I do not think we are far behind other countries in that respect.

MR. D. M. FOUNTAIN (John Mowlem & Co. Ltd.): Can Dr. Bonnell give us any examples of American methods of successful mechanization within the building industry?

THE LECTURER: A good deal of the plant which is now being used in this country for mechanization, particularly in connection with plastering, has come from America. I do not know the American industry personally, but I doubt very much whether they are more highly mechanized. They are definitely more highly organized and consequently are probably able to use mechanical plant more efficiently than we are.

MR. L. V. MERLIN (Chief Work Study Engineer, G. Wimpey & Co. Ltd.): When a builder has got an expensive piece of plant it is obviously up to him to use it as much as he can. If he is going to use it efficiently he has got to become efficient himself; so quite often, probably in every case, the mere fact of employing an expensive tool indirectly makes the contractor more efficient. Otherwise he is going to lose money. Therefore efficiency is a by-product of mechanization, and I wonder how much of the advantage which is credited to the machine is partly due to the fact that the contractor must operate efficiently?

The lecturer showed strapped bricks being unloaded down a ramp—well, I think you will agree that the obvious thing to do, when you unload, is to put the material right where you want it—that is, up on the building, which is what we try to do when using a tower crane. But in ensuring that the tower crane is used to the maximum advantage a great difficulty is in interrupting the normal work cycle for unloading. You have got a crane which is tied to a work schedule all day, and unless your deliveries are carefully phased—which is very difficult to ensure unless you have the full co-operation of the manufacturers—you will find in many cases that the man who is

delivering the materials has to wait a good deal longer than if we had the old unloading gang.

THE LECTURER: It is quite true that the use of mechanical plant, particularly expensive plant, forces the contractor to improve the whole of his efficiency. If, on the other hand, you took that piece of plant away from the contractor, he would probably slide back to a less efficient state. It is the combination of plant and efficient organization that counts. In one case we found that the introduction of a particular piece of plant considerably increased productivity, but about 60 per cent of that increased productivity could, I think, be attributed to improved organization and about 40 per cent to the introduction of the new mechanical plant.

MR. C. HAMMERSLEY (Richard Costain Ltd.): We hear a lot about the advantages of the tower crane, but somewhat rarely about its disadvantages. There was a time, not many years ago, when many small builders thought that the possession of a tower crane was an indication of status. In my experience the first thing one has to do is to ensure that the tower crane you get is the right one, and secondly, having got it, to use it in the correct application, since whilst a tower crane is a very useful tool for prefabricated construction, it is not necessarily as attractive for *in situ* construction. A tower crane can, of course, only do one thing at a time, and on building sites one often sees a crane lifting one particular piece to serve one trade, whilst other trades stand waiting for the crane to be free. It would seem that there is room for further development in high-speed hoists for certain types of construction, because you can buy several hoists for the price of one tower crane. On many sites of reasonable size it is often an advantage to use a combination of tower crane and hoist, especially on an *in situ* job. Whilst this does not necessarily apply with prefabricated construction, I do not think we should stress unduly the apparent advantages of the tower crane without at the same time remembering that the hoist still has an application.

THE LECTURER: I entirely agree. Of course, the hoist has its proper place. The crane is not the only form of mechanization. One has to use the different kinds of plant in such a way as to get the maximum advantage from them.

MR. O. J. MASTERMAN (Unit Construction Co.): Dr. Bonnell's paper has reminded us what a very old-fashioned industry we are working in, and he has shown us the very slow rate of development that has taken place in its mechanization. To give one or two instances. Why is it that mixers have developed very little in the last twenty years? Why is it that the only notable improvement in vibrators has come about through a Swedish patent? Why is it that these rather clumsy, expensive tower cranes have mostly been bought abroad? I think it is very disappointing, and I wonder whether it is our Research Station that is at fault or our manufacturers, or the builders themselves.* Cannot we get development done better and more quickly?

The other question I should like to ask is whether Dr. Bonnell has anything to tell us about two items which were not mentioned: the transport of concrete by pump, and the transport of concrete, or large prefabricated units, by air.

THE LECTURER: Taking the first question first, I have no hesitation at all in saying who is at fault. It is the user. The manufacturer, under adequate pressure, and given the proper incentives, will tend to develop those things which sell; and if you as a buyer are not satisfied with the article he is offering you do not have to buy it; and if you do not buy he very soon changes the article. I feel very strongly that if the builders and contractors of this country really made a bid for machinery which they consider to be most useful to them, it is highly likely that the manufacturing side

* On this point, see also p. 345 for an Appendix to the discussion.

would endeavour to provide it. We have not found it impossible to persuade the manufacturing industry to manufacture certain pieces of plant which we thought the building industry would require, and once there is a market it is worth while for the manufacturer to spend the money on development.

With regard to the pumping of concrete—we have not done a great deal of work on it. Concrete pumps have been used quite considerably, particularly in dam work. We did try a French machine which was designed to make pumping as simple as possible, but under the conditions that apply to building sites in this country we doubted very much whether it would be economical.

Transport by air depends entirely on cost. In America I think the experiment has been tried. Whether it is economical or not I could not say. But it is something that is likely to force itself into our field of vision in the not too distant future. It is such an obvious way of transporting a complete unit from the factory direct on to the site.

MRS. E. LAYTON (Royal Institute of Public Administration): I am concerned with an inquiry into Local Authority Building Organization, and I was very interested in something which Dr. Bonnell said about the need for co-operation between designers and contractors. Local authorities are very anxious to proceed for the most part by competitive tenders, and this method of course makes co-operation with the contractor very difficult at the design stage. I wanted to ask whether Dr. Bonnell thought that this co-operation means only a greater understanding by the designer of the possibilities of mechanization, knowledge of how tower cranes work and so on, or whether he means that the real possibilities of progress will have to come from much closer individual co-operation between the designers and the contractors, by negotiated contracts and such means.

THE LECTURER: There is no doubt at all that the designer must develop a greater realization of the problems involved in construction; this applies to local authority designers as much as to private designers. Whether this is going to lead to a closer link between the construction side and the design side and bring them under one control, I do not know. There is a considerable development along those lines in America, with the 'package deals', and there is of course the all-in service which is being developed in this country by which the architect and the contractor, working together, gain a greater realization of each other's problems, and therefore give an improved service. Whether that is the right development or not I should not like to say. It is an experiment which is being tried. If it is the right way, I have no doubt at all that it will prove a success.

Whether there are any other links that must be forged between the two sides is something to which the design and the construction sides of the industry in this country must give very serious attention. I think I can say this: that the last few years has seen a greater awareness on both sides of the need for a closer understanding, and the tendency at the present time is for each side to have more sympathy with the other.

THE CHAIRMAN: Dr. Bonnell has told us of nearly all the mechanical means which are at present available in this country, and I think he has indicated very clearly that we need fresh thinking about design and construction to bring the two closer together to the great benefit of the nation. Many great industries have progressed much further in relation to their development than the building industry has done. I so well remember seeing the first prefab, which was at that time unknown in England, and our mission brought back from America all the drawings and information which the Prime Minister had asked us to discover, if such existed.

I should like to propose a sincere vote of thanks to Dr. Bonnell for reading us

this paper and for enlightening many of us about the mechanization possible and frequently applied in England to-day.

The vote of thanks to the Lecturer was carried with acclamation, and the meeting then ended.

APPENDIX

MR. JOHN ANDREWS, of 100 Hemnall Street, Epping, writes:

I had the pleasure of hearing Dr. Bonnell read his paper on 'The Mechanization of Building Constructional Processes', and whilst agreeing with the whole substance of his remarks, I feel that one point raised [by Mr. O. J. Masterman, p. 343] during the discussion could, with profit, be taken one stage further.

The question as to the degree of responsibility between the constructor and the manufacturer of mechanical devices for the slowness of using and producing these aids allows of only one answer—supply must follow demand—and this must be created by the user, the contractor.

Builders, however, may only build what the designer allows, and to my mind the final responsibility lies between them and the building owner, although somewhat nearer the designer, for with the greatest respect to our Chairman, the architect at any rate ought to be better informed and attempt to influence his client accordingly.

For as Eden and Bishop stated in their paper, 'The Problem of Mechanical Handling in Building Operations', 'the part which handling techniques may play is limited by those characteristics of building operations which are dictated by the design'.

Until the designer starts thinking in terms of elements of construction which will permit the economical use of mechanical aids, and wins over the building owner to their use, the contractor is hardly in a position to stimulate their production.

I regret that time prevented my raising this matter at the meeting, but perhaps written contributions are in order.

RHEOLOGY: THE SCIENCE OF PLASTIC FLOW

A paper by

E. G. RICHARDSON, B.A., Ph.D., D.Sc.,

Professor of Acoustics and Reader in Physics, University of Durham, read to the Society on Wednesday, 18th February, 1959, with F. H. Banfield, M.Sc., Ph.D., F.R.I.C., F.R.S.H., Director of Research, The British Food Manufacturing Industries Research Association, in the Chair

THE CHAIRMAN: Those of you who expected to find Dr. Scott-Blair in this Chair will join with me in expressing sorrow at the news that he has been suddenly smitten with influenza.

I am not a rheologist or a physicist, but perhaps I may be a fairly good substitute chairman, in so far as I shall say very little myself but encourage all those others who have something really good to say to say it! Dr. Richardson, who is well known to rheologists, is this year's President of the British Society, and an expert on acoustics. To-day he is talking about rheology, pure and applied.

The following paper, which was illustrated with lantern slides and demonstrations, was then read.

THE PAPER

It is a matter of common knowledge that our fundamental ideas on the subject of the motion of fluids and of the resistance experienced by bodies exposed to a current of liquid or gas came from Newton. It was Newton who envisaged the flow over a solid boundary as being characterized by a gradient of velocity, the fluid in contact with the boundary being at rest, while successive 'layers' of fluid move with faster and faster speeds until the speed of the free stream is attained. The fluid is thereby sheared in the same way that a slab of jelly is sheared if, while its lower surface adheres to a plate, the upper surface is pushed aside by the hand. The rate of shearing is proportional to this gradient of velocity but it also depends on the physical properties of the fluid.

Much later, this conception was taken up by Poiseuille, who used it to compare the behaviour of liquids when subjected to shearing forces during flow. It is to him and to Hagen that we owe the idea of a particular 'coefficient of viscosity' as the property of a fluid which relates the shearing force to the gradient of velocity at the solid boundary which sets up the shear. Poiseuille sheared the liquid by making it pass through a narrow tube, and related the mean rate of flow through the tube to the dimensions of the tube and the viscosity of the liquid. In order to overcome the resistance of the tube to the passage of the

liquid through it—and thereby to shear the liquid—pressure must be exerted to force the liquid through the tube.

In a liquid which obeys Newton's law, increase of pressure or rate of shear on the liquid will increase the velocity gradient and so the rate at which the liquid passes through the tube *in the same proportion*. In other words the viscosity is a constant factor, unique for every 'Newtonian fluid' though it varies considerably from one fluid to another. A number of liquids and gases which are homogeneous (in the sense that we cannot by any means detect that they have different properties in different parts or when viewed in different directions) do obey the simple laws of viscosity, but in recent years an increasing number of fluids have been found to have different coefficients of viscosity at different rates of shear. On examination, it proves that fluids with this abnormal behaviour —'non-Newtonian fluids'—are heterogeneous: for example, they may have particles of a different nature floating about in the body of the liquid (*sols*) or possess a structure binding the mass together in a semi-solid mass (*gels*).

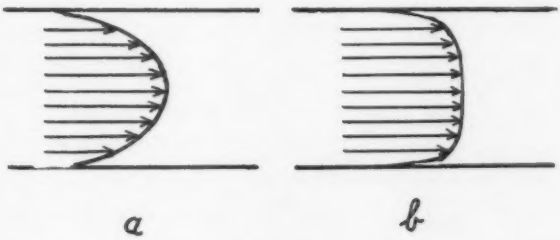


FIGURE 1. *Velocity distribution in flow:*
(*a*) *Newtonian;* (*b*) *non-Newtonian*

It is interesting to reflect that Poiseuille himself did find such anomalous viscosity. He was a physician interested in the mechanism by which the blood passes into the smaller vessels or capillaries and did some experiments with blood solutions forced through narrow tubes. (To this day we speak of such tubes as 'capillary' tubes.) Blood is not a homogeneous liquid; it has corpuscles floating in it, though not in sufficient concentration to show much change of viscosity with rate of shear.

In a Newtonian fluid, the velocity varies in parabolic form across the section of a tube: see Figure 1*a*, where the lengths of the arrows represent the relative speeds.

Figure 1*b* shows how the velocity of flow of a markedly non-Newtonian liquid varies across a tube in which it is flowing. The velocity is nearly constant across the major portion of the tube and falls in a steep gradient to the walls. Hence, this type is known as plug flow. Although it is very difficult to measure the velocity from point to point across a narrow tube, it may be done if the liquid is contained in the space between two coaxial cylinders, one of which—usually

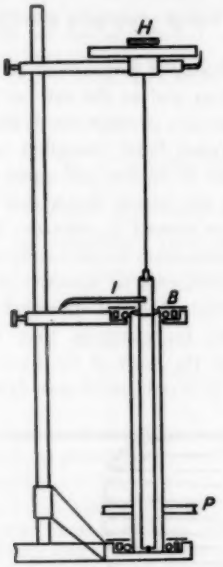


FIGURE 2. *Concentric cylinder viscometer. The outer cylinder is rotated in ball bearings B through the pulley P. The inner cylinder carries a pointer I which moves over a horizontal scale. The liquid is placed in the space between the cylinders and the initial position of the inner cylinder can be adjusted through the head H*

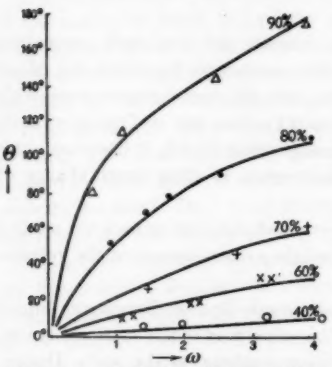


FIGURE 3. *Deflection of inner cylinder θ versus angular velocity ω of outer cylinder. The numbers attached to the curves are the concentrations of the suspended material in the liquid*

the outer—is rotated while the other is held at rest. The liquid moves in a series of concentric rings and is sheared in the process (Figure 2).

If then we put a homogeneous liquid into the apparatus, the ratio of this twist to the speed of rotation of the outer cylinder is a constant, proportional to the coefficient of viscosity, but with a non-Newtonian liquid the torque increases rapidly at first (as the outer cylinder speeds up) and then moves more slowly so that the ratio torque: speed of rotation called the 'apparent viscosity' decreases as the rate of shear on the liquid increases. This is a common feature of these anomalous liquids, and one of considerable technical importance (Figure 3).

A homogeneous liquid has also this property, in acordance with Newton's law, that it begins to move under the smallest possible shear. The smallest appreciable pressure drop along a tube or the smallest possible application of turning moment to the outer cylinder in the apparatus of Figure 2 is enough to start the liquid moving. When the concentration of the material in suspension in the liquid is high, when it forms, in fact, a fairly stiff paste, however, it is found that the substance will bear small shearing forces without starting to move. The existence of such a 'yield value' in, for example, pastes of modelling clay makes it possible to mould them into a shape which they will retain for some time—they are, in fact, plastic; in a rather similar fashion confectionery jellies may be set in a mould on a plate and, after removal of the mould, the

mass will retain its shape, in spite of the force of gravity urging it to flow out over the plate.

The number and nature of the grains or corpuscles in the suspension has an important effect on its flow properties. If they are concentrated and tend to coagulate, it requires an effort to get the suspension to move—one has first to break up the aggregates. This plastic property is well shown by clay suspensions. So we find dialect words—characterizing this property. In the North, we speak of mud as 'claggy', in Sussex as 'cledgy', if it sticks to the spade in digging. Less viscous soils may be 'slubby' or 'slabby'.

Usually, if the suspension has fine grains among coarser ones, the fines 'lubricate' the suspension. It becomes more fluid and less plastic. Also, if the material in suspension consists of needle or plate-shape bodies, these tend to align their longer dimension along the direction of flow once started, and the system moves readily.

The rolling of dough presents interesting problems. Too much extension will cause the baton to break. While the possession of great tensile strength (resistance to rupture on extension) is not a matter of first importance in dough as such, there are other food processes in which it is desirable that the preparation should possess it. In making some kinds of toffee, for example, strands of the confection are pulled and interwoven by a machine which secures adequate blending and working of the ingredients. This process would fail were the mix to break up easily into lumps. Similar considerations apply to the uniform spreading of honey on bread if lumpiness is to be avoided.

Plasticity and elasticity are of fundamental importance in the rising of the dough after the ferment is added. In one apparatus of routine testing a thin pat of dough closes one end of a cylinder into which air is blown at a constant rate so that a bubble is blown with the material of the dough. The bubble may be blown until it bursts and the pressure change inside it recorded during the process, or the pressure may be released at a moderate value and the dough allowed to relax. At first the pressure rises rapidly, then more slowly as the dough begins to yield, and the bubble swells until finally it swells faster than the influx of air. During this stage the pressure inside the bubble falls. The pressure at the point of rupture is a measure of the tensile strength of the dough film. The whole area between the pressure curve and the time axis is a measure of the work done on the pat of dough. The more elastic it is, the less work has to be done on it.

The setting of a gelatine solution is an interesting case in which a liquid acquires internal structure by the reduction of its temperature and becomes a gel, possessing both yield value and elasticity. (The latter factor is evidenced by the way in which jelly, partly displaced from equilibrium, 'shimmies' to and fro and eventually returns to equilibrium. The gel can be transformed back to the sol by heating or, sometimes, by shaking. A system which possesses gel-characteristics when left alone, but becomes (temporarily) a sol when disturbed, is said to be 'thixotropic'. A good paint should possess this property, so that it can be brushed or sprayed over a surface smoothly and retain a uniform

FIGURE 4. *Swelling of rubber solution as it debouches from a narrow tube.* (*Photograph: A. C. Merrington*)

texture and gloss when left. Further, although it has a high viscosity when settling down slowly over the surface it has to cover (and this promotes a good 'finish'), yet when forced out of the spray nozzle at high speed its viscosity is low and energy losses in the nozzle are so reduced to a minimum.

Finally, some liquids, particularly solutions of rubber in benzene, exhibit bulk elasticity. If a rubber solution is forced through a capillary tube, it is found that on emergence the liquid swells out to a diameter greater than that of the tube (Figure 4). Evidently under the influence of the pressure used to force it through the tube it had contracted laterally on entry and relieved itself of this constraint on leaving the tube.

It should be added that rubber, clay, and even metals show analogous behaviour under stress, but the latter require much greater stresses and show a proportionately smaller change of size. It is doubtless the cellular structure of rubber and dough which causes them to give way to comparatively small tensions. When a soft metal such as aluminium is being extruded from a die with the object of forming a thin wire, it does in fact show the same elastic swelling on which we have remarked when dough is extruded from a syringe; but whereas flour demands pressures of the order of ten pounds per square inch, the metal may need a force of some tons per square inch to show this effect.

The existence of such 'normal stresses' can also be shown (following Weissenberg) by rotating a stick in such a liquid, which thereupon climbs up the stick (Figure 5).

The importance of this property can be realized when it is pointed out that besides rubber solutions such diverse materials as dough, cheese, cream and animal muscle have been found to exhibit elastic after-effects when forced to flow.

The elasticity exhibited by such liquids links them in behaviour with solids, for it is primarily to a solid that we ascribe a proportional strain resulting from an applied stress (Hooke's law). In a true solid, however, this relationship is independent of time, while an inviscid fluid is incapable of sustaining a strain unless it is contained in an hermetically sealed vessel; but if a liquid possesses viscosity, has room to flow and is stressed, the stress will dissipate itself (by the movement of the fluid) at a rate which Clark Maxwell assumed to be proportional to the strain existing at any instant. Thus, on the application of the stress the comparatively large initial strain results in a rapid flow which decreases as the strain is relieved. The factor of proportionality is related to the time which the

liquid takes to relax, namely, to relieve itself of the stress applied to it. Maxwell showed that this 'relaxation time' should be equal to the quotient of the coefficient of viscosity by the modulus of rigidity. Figure 6 shows a model for a Maxwell fluid. It consists of a spring and dashpot in series.

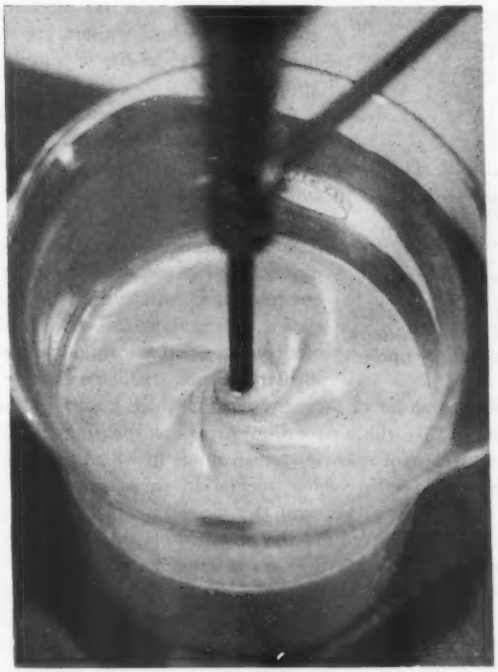


FIGURE 5. *Rod rotated in condensed milk which thereupon climbs up rod.* (*Photograph: G. W. Scott-Blair*)

This relaxation time can be measured by means of the apparatus shown in Figure 2. If, for example, a rubber solution is placed between the cylinders, and the outer one rotated through a right angle and then held still, the inner one will follow quickly through a smaller angle, indicating that the sol is able to bear the torque (measured by the difference in angular position of the two cylinders) at first. It will not hold this stress indefinitely and it will be found that after an initial rapid deflection of, say, 60°, the inner cylinder will gradually creep up to the same deflection (90°) that the outer one was given. If a true liquid is put in, the inner cylinder *at once* copies the deflection of the outer one. (It is assumed in these experiments that the thread supporting the inner cylinder is long and incapable of exercising appreciable restraint on its movements.)

FIGURE 6. *Maxwell model to represent fluid having viscosity (dash-pot) and elasticity (spring)*

If an alternating stress is applied to a Maxwell model, for example, by moving the upper end of the wire rapidly to and fro at a period less than the relaxation time, the cylinder will not be able to respond and the system will behave as though it had elasticity but no viscosity. Thus, time effects are of great importance in studying the behaviour of visco-elastic liquids under alternating stresses.

An apparatus in which the viscous and elastic factors can be separated is shown in Figure 7. It consists of nickel rod at one end of which a coil excites torsional vibrations. These are transmitted along the rod but the liquid surrounding it adds to its mechanical impedance. This additional load is measured electrically and sorted out into its viscous and elastic factors. Figure 8 shows, for example, these two factors in the case of a cooling gelatine solution as it passes through the temperature, at which it changes from sol to gel.

We have written so far of those systems in which a solid is 'dissolved' either as a true solution (like rubber solution) or as a suspension (like clay in water). There is another class of non-Newtonian fluids in which both phases are fluid. These are the *emulsions* in which one liquid subsists as globules in another forming the continuous phase, and the *foams* in which a gas is dispersed as bubbles in a liquid. Both require the presence of emulsifying agents (of which soap is a common instance) if they are to remain stable and not settle out into two discrete constituents, one above the other. The action of such an agent is rather obscure but it is believed to be connected with the electrical sheath with which it is able to surround the drops or bubbles. Whatever the consistency of such sols, whether definitely fluid like mayonnaise and bath foam or solid like margarine and chocolate sponge mixture, these systems are of considerable technical importance. They all exhibit, in the concentric cylinder apparatus, a viscosity decreasing as the rate of shear increases. With the stiffer emulsions there is a critical velocity—something analogous to the yield value already referred to—below which the substance does not flow at all. Below this speed, the emulsion behaves as a solid, above it as a fluid with rapidly decreasing viscosity as the structure within it is broken down under stress.

FIGURE 7. *Apparatus for propagating shear waves in liquid*

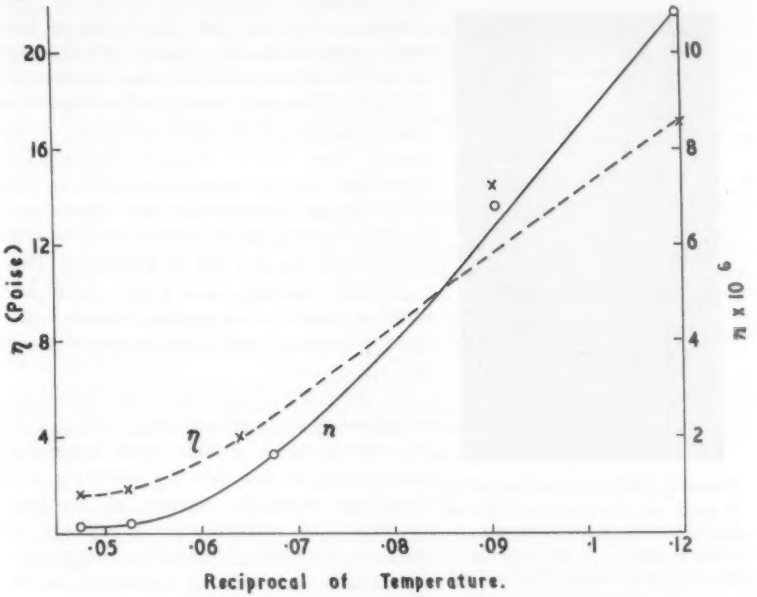


FIGURE 8. *Change in viscous factor* (η) *and elastic factor* (n) *in gelatine solution as its temperature falls*

If the globules are large enough, then when sheared by the general flow the liquid inside them may be set in rotation (Figure 9), a state of affairs which results in an increased rate of dissipation of energy into heat. In consequence the viscosity is greater than it would be if the globules remained rigid spheres.

Up to this point, I have been treating almost exclusively fluids in which the matrix is a liquid, but there are others in which a gas—usually air—carries particles in suspension. In the last few years these have assumed industrial importance under the name 'fluidized powder beds'. It is here a question of getting a fine powder, such as china clay, conveyed in the dry state along a channel. This is done by a fast stream of air. Such a system obeys similar laws to those of a suspension in a liquid as to apparent viscosity and yield value.

There are important applications of rheological principles in biology. Muscle is a visco-elastic substance which behaves differently when a stress is suddenly applied to it from when the same stress is applied gradually, but—unlike some of the inorganic substances we have been discussing—will recover from any strain in time. This is because chemical restoration of overstrained or torn muscle takes place.

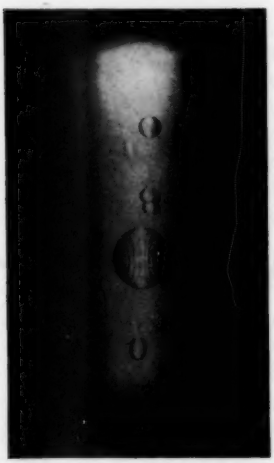


FIGURE 9. *Drops of glycerine falling in castor oil. The glycerine has been dyed locally to show the internal circulations induced by the shearing of the liquid in the drop.* (*Photograph: K. Spells*)

A number of biological secretions are non-Newtonian in their flow properties, so that their apparent viscosity varies with the rate at which they are sheared in a viscometer. Indeed, such measurements can give important data about the physiological condition of the animal from which they are derived. Dr. Scott-Blair and his associates have shown that such changes occur in the visco-elastic properties of certical secretions during the oestrus cycle of the cow and also in pregnancy. This is just one example; in a recent rheological congress, there were papers on chronic bronchitis, protoplasm and the properties of blood and blood vessels.

Dr. Scott-Blair has also made important contributions to psycho-rheology, that part of the subject which studies those subjective tests which involve flow or plasticity and which are especially common in the food industry. Such properties as 'consistency' in cheese, 'spreadability' in butter and margarine, 'shortness' in bread are all capable of test by the rheologist with his apparatus, though rarely are these qualities judged in isolation. In making his assessment of subjective rheological factors, the routine operator will often be guided—perhaps subconsciously—by other factors such as colour or smell which do not really affect the flow properties.

Indeed the rheologist need not confine himself to laboratory tests; his subject embraces the earth and he can look farther into the solar system. Thus the peculiar formations at the Giants' Causeway in Ireland have been ascribed to rheological flows 'frozen' into position in past ages. The subject of magneto-hydrodynamics, which deals with the interaction between magnetic fields and viscous flows in, for example, the sun, is also a branch of rheology.

DISCUSSION

MR. A. DE WAELE, F.R.I.C., F.INST.P.: In reference to the relationship between the coefficient of viscosity η, the rigidity G and the time of relaxation T, I fail to understand the meaning of rigidity as applied to a true liquid. Is there any means of determining this function? Would Dr. Richardson confirm that the singular behaviour of silicone putty is attributable to its being indeed a true fluid of very high viscosity and devoid of any yield value? Attempts to match the consistency of silicone putty by introducing a solid powder into a fluid merely result in normal plasticity comprising a yield value and devoid of the free flow exhibited under small stresses by the silicone putty.

THE LECTURER: You have to do an experiment of the kind I described

[Figure 7, p. 352] in which you send shear waves into the liquid and try to sort out the two components, one of viscosity and the other of elasticity. I do not think that with the conventional type of torsion apparatus you could demonstrate rigidity in these substances; you would probably find that your apparatus was recording yield value rather than rigidity in the sense that most of us understand it. So I think you are quite right; it is not possible to measure directly the elasticity of a liquid as such; but with appropriate apparatus it is possible to derive quantities proportional to rigidity and viscosity.

I have done so myself and some years ago Dr. Weissenburg did a similar sort of experiment. You take a dish on an oscillating table and put in a visco-elastic liquid and oscillate it through a small angle; then you can show it has rigidity, because at the appropriate frequency you get a sort of resonance. Weissenburg showed this with a powder on the surface; I did it by probes measuring local velocity amplitude. There is a kind of stationary wave system set up across the surface, providing that you have the right frequency. I think it is only in an experiment like this that you can actually measure the rigidity. You cannot expect to do it by type of apparatus such as is used on solids.

Your other point concerned the silicone putty: I myself tried without success to make some relaxing solids with plasticine and oil and things like that. It appears that the putty has an interwoven structure which resists breakage for a short time but is not able to do so where forces act on it over a long period.

MR. A. S. FREEBORN: Is it true to say that in a system showing thixotropy there is an optimum ratio of solid to liquid for maximum thixotropy?

THE LECTURER: I am not sure about that. In the one I showed the pigment is 33 per cent, the non-volatile binder is 30 per cent and the volatile 37 per cent. I am not a paint specialist, but I have consulted the people who supplied the paint and they say that the degree of thixotropy is controlled in the 'cooking' process, whereby the gel is produced, and not by the initial proportions of pigment and binder, which are not critical.

DR. R. GAZE: I should like to ask two questions. The first is prompted by idle curiosity. Are there any non-Newtonian liquids in which increasing shear increases the viscocity? Secondly, I understood the lecturer to say that the unusual properties of non-Newtonian fluids result from the presence of solid particles, or granules, in suspension in another media. Is it possible to interpret the non-Newtonian behaviour of these systems in terms of the size, chemical composition or shape of these granules or particles?

THE LECTURER: With regard to the first question: yes, there are some substances usually called dilatant. This property of dilatancy arises usually from some change of structure caused by higher rates of shear, whereby it does acquire a higher viscosity. Those substances are rather rare and I have never actually worked on them myself.

About the solid particles—one has to be careful here. Usually, if there is no interaction between the particles, then there will not (at least, in my experience there will not) be non-Newtonian flow—that is to say, if you only have a few particles, a very dilute suspension. The overall viscosity will be affected by the concentration of the solid which is in suspension, but I think it is only when there is either a true elasticity, a true gel structure, or when the particles are so numerous that they get in each other's way when they move, that you get this reduction of viscosity, as the substance is sheared more. Chemical composition does, of course, enter in because it is often chemical composition that affects this structure. Indeed, it may destroy the structure if you put the right chemicals in. So you can chemically alter the non-Newtonian behaviour of the substance, make it less or more, as you please.

MR. J. LLOYD OWEN, M.A., B.SC.: Practical chemical engineers have come across

a very interesting phenomenon in connection with pulping paper pulp. As the velocity of pumping increases so does the frictional loss, but after a time, provided the concentration of solid pulp is sufficiently high, the frictional loss falls off and the power curve flattens out. It may even dip in value below that of pure water, with the result that it becomes possible to pump the paper pulp with less power than pure water requires at that velocity. Various explanations have been given, none of them completely satisfying, and I wonder if Dr. Richardson could tell us what he thinks?

THE LECTURER: I am afraid I have never thought about it! I am very surprised that the viscosity becomes less than that of ordinary water.

MR. LLOYD OWEN: They do not claim that the viscosity becomes less, but only that the power required falls.

THE LECTURER: Well, I am afraid I cannot offer an explanation of that.

THE CHAIRMAN: As one connected with the food industry I should like to make a mild protest about the use of the phrase 'routine analysts'. I had the opportunity of looking at the proof of Dr. Southgate's paper. He said that the 'routine analyst', in assessing the rheological properties of consistency in cheese, spreadability in butter and margarine, shortness in bread, will be guided, perhaps subconsciously, by other factors such as colour or smell, which cannot really affect the flow properties. As an ordinary consumer I would admit that we are sometimes affected by colour, smell, and all the other things that affect the emotion of eating, but surely, in this respect, the analyst, by virtue of his scientific training, would disregard the side-issues!

THE LECTURER: I did not know quite what to call this person! I do not like to say 'rheologist', because I know the tests are not done by people who happen to call themselves professional rheologists. I think it is a word that somebody else used—it may have been Dr. Scott-Blair in a book. What name do you think I should give to the persons?

THE CHAIRMAN: I must have notice of that question, but certainly not analysts!

MR. HIRAM BARTON: I was most interested in the slide which showed the rubber coming out of a narrow tube and enlarging in diameter, because that is an effect which also occurs in the die-casting of metals, where you have thin liquid films flowing at speeds in excess of perhaps twenty metres per second in contact with a chilling surface, and where in consequence you get a velocity gradient through a jet of metal a few thousandths of an inch thick. Because of this effect of forces normal to the direction of flow, such films will in fact change direction through almost 90 degrees without leaving the surface. This is a point of considerable practical importance in some instances.

MR. A. DE WAELE: Perhaps I may help the gentleman who asked about dilatance of non-Newtonian fluids. A simple preparation exhibiting dilatancy in non-Newtonian materials can be obtained by making a 5 to 10 per cent paste of Anatase titanium oxide in 'straight' mineral oil, e.g., liquid paraffin. This exhibits a quasi-dilatancy not to be confused with the true dilatancy of Osborne Reynolds, which depends on close piling. When stirred slowly, it behaves as a thick liquid or soft plastic, but when stirred rapidly it sets up a rigidity sufficient to break the stirring rod. A liquid exhibiting elastic properties is obtained by stirring a few drops of oleic acid into dilute ammonia. Stirred slowly with a rotary motion it behaves normally, but when rapidly stirred it 'unwinds' as stirring is stopped. There is, so far as I know, no generally-accepted explanation of the phenomenon, but as it seems to be confined to a solute of long molecules, I suggest for what it is worth that an entanglement by adlineation is responsible.

THE CHAIRMAN: It is my privilege to record our gratitude to Dr. Richardson for coming down from the North to talk on this subject. He has gone from the heights of

sublimity, occupied by the pure physicists, right down to the depths occupied by myself in the food industry, whose members are the producers of materials which add to our delight and very often puzzle us by their intricacy. May I finish with one final little dig about a sponge? I should like to see my colleague Mr. Steiner putting a chocolate sponge in his roto-viscometer. I think it is a sponge emulsion before it goes into the baking tin, whereas we in industry refer to the sponge as what comes out of the oven.

The vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman, the meeting then ended.

GENERAL NOTES

SOME MODERN ART EXHIBITIONS

Fellows of this Society who have contrived to keep abreast of the continually changing tendencies of modern art will certainly be familiar with the movement, broadly termed Abstract Expressionism, which made its appearance in America and France in the later 'forties, and has since become an international idiom. The purpose of many of these abstract artists is two-fold. They seek to exploit all the potentialities of pigment and various textures with an individual fancy and freedom that has seemed to them to burst the strait-jacket of the earlier rigid formation, and at the same time to give coherency on canvas to the indefinable sensations provoked by contemporary life. If that sentence sounds pretentious, it can be said that it is the bluntest possible summary of innumerable views expressed in the quasi-mystical manifestos which have accompanied this 'other art', as it has been called.

It follows that such painting is very much an acquired taste, and no doubt a taste only for the best of it is worth acquiring. By general consent, the late Jackson Pollock and some of his living associates in the United States are among the best in this field, and for the first time in art history New York can be said to have wrested the hegemony from Paris in recent years. An imposing exhibition of this *New American Painting*, organized by the New York Museum of Modern Art and brought to the Tate Gallery by the Arts Council, was therefore something of an event, and its very recent closure (on 22nd March) need not preclude a retrospective mention. What stays in the memory is the assurance with which the mostly huge abstract designs dominated the great white partition-walls specially constructed at the Tate. Few of the seventeen artists, it is true, could rival Pollock's obsessional urgency; but again and again one was aware of mysterious suggestions of our contemporary dilemma, and of the phenomena of our day, which is the peculiar province of this mode of painting. Mark Rothko's paintings, for instance, may arrest one not simply for the strange tonal relationships of the areas of colour, but also, on an imaginative level, for the sense they convey of unnaturally luminous fields, tranquil yet ominous after some nuclear convulsion.

As might be expected, the deceptively simple appearance of such abstract expressionism, allied to alluring surface textures, has seemed to a host of impressionable young painters in this country to represent the be-all and end-all of art. In the last two or three years, indeed, a deluge of insignificant doodling in paint has flooded into London dealers' galleries, tending to debase a movement whose vitality and significance reside, as we have seen, in the experiments of some leaders abroad. One result in London has been the declining quality of the Young Contemporaries exhibitions. In the tenth annual show by these British art students, seen earlier this month in the R.B.A. galleries, there were certainly fewer slapdash abstractions than crowded the walls in 1958, but even so the standard generally was unimpressive.

The task of the prize adjudicators must have been depressing, but the awards on this occasion went rightly to students of the Royal College of Art and the Slade, who

were most conspicuous in every room. Besides the Royal Academy's and Arts Council's prizes, there is a bi-annual award of £100 for sculpture given by M. André Susse, the recipient this year being Corinne Webb for her craggy torsos in the overwrought expressionist style so prevalent in art schools. Possibly a more deserving candidate was Janet Williams, whose little head in glinting bronze, tinged with melancholy, revealed a sensitivity denied to the run of brutish sculptures. An innovation this year was a stained-glass section, which seemed to comprise as much lead as dusky glass, and disappointed expectations.

Mr. John Bolam, an imaginative abstractionist who contributed to one of the earliest exhibitions of the Young Contemporaries when it was a coveted distinction to be hung there, has been sharing the Heffer Gallery at Cambridge with Mr. Shelley Fausset, another intensely serious and inquiring artist in his late thirties.

It was during the last war that Mr. Fausset found his vocation in sculpture, becoming an assistant to Henry Moore before going to the Slade School, fortified by that practical and invaluable experience. While his material evidently takes its part in the shaping of an idea—a monumental seated figure, for instance, will preserve its hard, tense stoniness, and some relationship to the block from which it was carved—it is equally clear that Fausset never loses sight of the humanist element. Finding sustenance in Rodin, while remaining acutely conscious of contemporary tendencies, and holding fast to his concept of imaginative humanism, Shelley Fausset has advanced at Cambridge as one of the most interesting sculptors of his generation.

NEVILE WALLIS

TREASURES OF CAMBRIDGE AT GOLDSMITHS' HALL

The superb array of treasures enriching the handsome exhibition rooms at Goldsmiths' Hall, London, until 18th April, include the most precious possessions of the colleges and museums of Cambridge. They include, for example, the priceless *Four Gospels* sent by Pope Gregory to St. Augustine shortly after his arrival in England during 596 to become the first Archbishop of Canterbury. But they also acknowledge the University's leading scientific rôle in the world to-day by including, for example, scientific apparatus used by Lord Rutherford in the experiments which resulted in the splitting of the atom in 1919. The five hundred exhibits ranging between these years have never before been seen outside Cambridge. They include historic portraits and old master paintings, gold and silver plate, sculpture, watches and jewellery, rare books, illuminated manuscripts and scientific instruments. The works of art lent by the Fitzwilliam Museum alone have been valued at half a million pounds.

The historic scientific instruments are, with one exception, from the Whipple Museum and include an English astrolade made in about 1400; a silver terrestrial globe of the second half of the sixteenth century engraved with a map of the world by Paolo da Furlani of Verona; a telescope with tubes of vellum-covered pasteboard giving a magnification of nine times, made and signed in about 1690 by John Yarwell of London; an armillary sphere showing movements of heavenly bodies, made in about 1720 by Richard Glynne of Cheapside.

Modern scientific instruments from the Cavendish Laboratory, now considered the original home of nuclear physics, include apparatus used by Sir J. J. Thomson when he discovered the electron in 1897 and Sir James Chadwick's neutron chamber with which, in 1832, he proved the existence of the neutron.

The handsome display of silver plate by such twentieth-century masters as Leslie Durbin, J. G. Stapley, C. J. Shiner, and Francis Cooper has been commissioned by and for colleges during the past fifteen years, often by Fellows commemorating a personal occasion. Courageous design combined with masterly craftsmanship incorporating the experience of centuries, and impeccably prepared metal, form a distinguished contrast with the antique plate. Contemporary gold plate is rare, but

here is displayed a gold paten given to Jesus College in commemoration of the Coronation. This was designed and engraved by T. C. F. Wise in 1953.

Cambridge is, obviously, celebrated for the splendour of its historic plate. The Exhibition includes 62 examples of pre-Commonwealth plate, rare because of the enormous destruction following the Reformation and again by Cromwell who, under stress of civil war, diverted both chapel and secular silver from Cambridge to Goldsmiths' Hall for the benefit of the Parliamentary Exchequer then housed there.

None of the medieval chapel plate remains, but a few small examples of secular plate escaped destruction. The oldest piece, a silver-gilt beaker and cover dating to the first half of the fourteenth century, was the property of William Bateman, who founded Trinity Hall in 1350. This is struck on both base and cover with the arms of Pope Innocent VI. Bishop Bateman was ambassador to the Papal See of Avignon at the time of his death in 1354/5, and the marks no doubt indicate former Papal ownership. The silver plate from which it is wrought is of such poor workmanship that English origin might well be envisaged. From this period to the present day there has been a slow chronological improvement in sterling silver plate consequent upon advancing industrial processes. This is to be detected in the seven-hundred-year sequence of plate on view, which includes standing cups of distinguished design, handsome tankards, exquisitely embossed rosewater ewers and basins, standing salts, capacious punch bowls hand-raised from the plate, candlesticks, and so on.

There was a medieval belief that coconuts possessed magic powers when used as drinking vessels, so that they were considered worthy of mounting in silver. Gonville and Caius has lent such a cup attributed to the fourteenth century and enriched with gilt mounts. There is also an ostrich egg-cup from Corpus Christi and a 'serpentine pott' from Clare, both of the late sixteenth century.

The 'Poison Tankard' of Clare College, described in the will of its donor, Dr. William Butler (d. 1617) as a 'pott made of Christall, Pearl and Silver', was believed to shatter if any poisoned liquor were placed in it. The tankard consists of a crystal beaker contained in a cage of filigree silver enriched with pearls. Apparently the experiment has been made with success, for the costly beaker cut from a single piece of rock crystal is now replaced by a glass drum.

Ancient manuscripts lent by the University library form a marvellous collection in themselves. Included is the celebrated sheet from the fifth-century *Codex Bezae*, with the *Gospels* and the *Acts* in Latin and Greek. A medieval monk's sketch-book from the Pepys Library contains reference studies made in the late fourteenth and early fifteenth centuries. Particularly interesting are the birds, then fashionably embroidered on vestments, such as the Syon cope.

The nautical-minded will view with delight *Henry VIII's Navy* by Anthony Anthony, 1546, also from the Pepys Library. This was originally in the form of parchment rolls, cut into sections by Pepys and bound more conveniently into a large folio volume. The fascinating illustrations depict the general features of every type of craft sailing the seas in Henry's navy. *The Harry*, for instance, is shown to be a four-masted galleon bristling with guns—44 are visible on the port side and stern, 88 all told. Pepys wrote on the title page: 'Given mee by my Royall Master K. Charles ye 2d'.

Curious is the fragment of shroud pinned into the *Diary* of Symon Patrick (1626–1707) lent by the University library. In 1685, whilst scaffolding in Westminster Abbey was being removed after the coronation of James II, the coffin of Edward the Confessor (1042–1066) was accidentally broken. A golden cross and chain with fragments of the shroud were removed. A piece of the fabric came into the possession of Patrick, then Prebendary of Westminster, and when he wrote his account of the breaking of the tomb he pinned his fragment of the shroud to the page.

G. BERNARD HUGHES

THE A.B.C.C. COMMERCIAL APPRENTICESHIP SCHEME

Nearly two years ago the Association of British Chambers of Commerce instituted its Commercial Apprenticeship Scheme, which has since aroused widespread interest among educational authorities and business organizations in this country. Mr. E. Tonkinson, M.Com., B.Sc. (Econ.), Secretary, Commercial Apprenticeship Board, has contributed the following account of the purpose, scope and progress of the scheme:

Keeping the office in step with technological advances on the shop floor underlines the need for education and training on the administrative and commercial side. In post-war Britain great emphasis has rightly been laid on technical training, but training for commerce has failed to keep pace. Facilities for training in individual companies should be balanced as between the commercial and technical needs of the enterprise, and on the commercial side new skills must be developed. The office, hitherto starved of suitable recruits, must receive a full share of well-trained manpower.

To further this aim, the Association launched, in May, 1957, the first national Apprenticeship Scheme for Commerce in the United Kingdom.

The Scheme is designed to give a comprehensive 3–5 year combined academic and practical training for employees, to raise the general level of such training and to provide well-trained personnel, from which some of the future managements may well be drawn: a practical scheme, launched by business men for self-help and in the long-term interest of industry and commerce.

It is run by Chambers of Commerce affiliated to the Association. Boys and girls in England and Wales, entering industry at 16, with a General Certificate of Education in three prescribed subjects, may, through their employers, enter a five-year apprenticeship. The older entrant, at 18, with G.C.E. 'A level' in two subjects may undertake a 3–4 year apprenticeship. These requirements may be modified in certain approved cases. Special entrance requirements apply for Scotland.

Each company joining the Scheme provides, under a deed of apprenticeship, a well-designed practical training in selected offices, departments or activities of the firm, which is approved by either the national Commercial Apprenticeship Board in London or Scotland. At the same time each apprentice will be allowed at least one working day a week for two years, in order to study at the local Technical or Commercial College for the Ordinary National Certificate in Commerce, or its Scottish equivalent, if he is under 18. Then both the younger and the older apprentices will be given similar part-time day release for the remainder of their apprenticeship period to study for a Higher National Certificate in Commerce, or its Scottish equivalent, or an approved professional examination. Each apprentice will be expected to do a reasonable amount of evening study in his own time.

On the successful completion of the apprenticeship, the apprentice will be awarded a Diploma or Certificate in Commerce by the Association of British Chambers of Commerce.

Since its inauguration, 114 Companies and over 200 Apprentices have joined the Scheme in the United Kingdom. Seventy are in England and Wales, and 44 in Scotland. During the first year the main support has come from medium/large companies in the manufacturing industry, many of whose names are household words. At the beginning of its second year, the Scheme continues to make slow but steady progress, but it now faces a critical test in recruiting medium/small companies, whose needs for adequate education and training facilities are just as great.

Further details of the Scheme may be obtained from the Association of British Chambers of Commerce, 14 Queen Anne's Gate, S.W.1 (Telephone WHItehall 2494).

1959 WAVERLEY GOLD MEDAL COMPETITION

For the seventh year in succession, *Research*, the well-known periodical, is offering the award of the Waverley gold medal, together with a prize of £100, for the best essay (of about 3,000 words in length) describing a new scientific project or practical development, and giving an outline of its scientific background, experimental results and potential application in industry.

The competition is designed to encourage improvement in the writing of reports of scientific and technical work, and essays will be judged for both technical content and clarity of style. A second prize of £50 will be awarded, and also a special prize of £50 for the best entry from a competitor who is under the age of 30 on 31st July, 1959 (which is also the closing date for receipt of entries). The Editor, *Research*, 4–5 Bell Yard, London, W.C.2, will supply full details and application forms.

CORDAY-MORGAN MEDAL AND PRIZE FOR 1958

The Chemical Society offers the award of the Corday-Morgan silver medal and prize of 200 guineas to the chemist who, in the judgement of the Society's Council, has published the most meritorious contribution to experimental chemistry during 1958, and who has not, at the date of publication, reached the age of 36. Men and women of British nationality are eligible for this award. Applications or recommendations in respect of it must be received by the General Secretary of the Society at Burlington House, London, W.1, not later than 31st December, 1956. Copies of the rules governing the award may be obtained from this quarter also.

'TECHNOLOGY TO-DAY AND TOMORROW'

Faber and Faber announce the forthcoming publication of a new series of books, with the general title 'Technology To-day and Tomorrow', edited by Dr. P. F. R. Venables, Principal of the Birmingham College of Technology. The series is designed for the student and professional scientist and technologist. It has been planned to help the specialist to take account of the economic, social, political and philosophical implications and consequences of his work in Society at large. All the titles have been specially commissioned, and they cover a wide range of general studies, from the development of ideas to the social and economic conditions which have influenced innovations in science and technology. Amongst the first titles announced are a study of *Technology, Design and Aesthetics*, by R. H. Litherland, *A Social History of Engineering*, by Professor A. F. Burstall, and histories of mechanical and electrical engineering, by Professor W. H. G. Armytage and Dr. P. Dunsheath respectively. The price of each volume will be about a guinea, or twenty-five shillings. Publication dates are not yet fixed. Further information about the series may be had of the publishers at 24 Russell Square, London, W.C.1.

STUDIES IN THE SOCIETY'S ARCHIVES V

Premiums for Paper: The Society and the Early Paper Industry

Within a year or two after its foundation in 1754, the Society's attention was drawn to some of the problems allegedly besetting the manufacture of paper in England. Thereafter, in the course of nearly half a century, it gave some £320, in premiums or medals, to fifteen persons who contributed to the solving of those problems.

The topics which thus exercised the Society, and the applicants for its awards, were five in number. They were: the manufacture of paper for printing copper-plate engravings, the making of drawing paper from silk rags, 'marbled' paper, and embossed paper; and the making of paper directly from various vegetable substances.

The first four of these subjects of concern may conveniently be considered together,

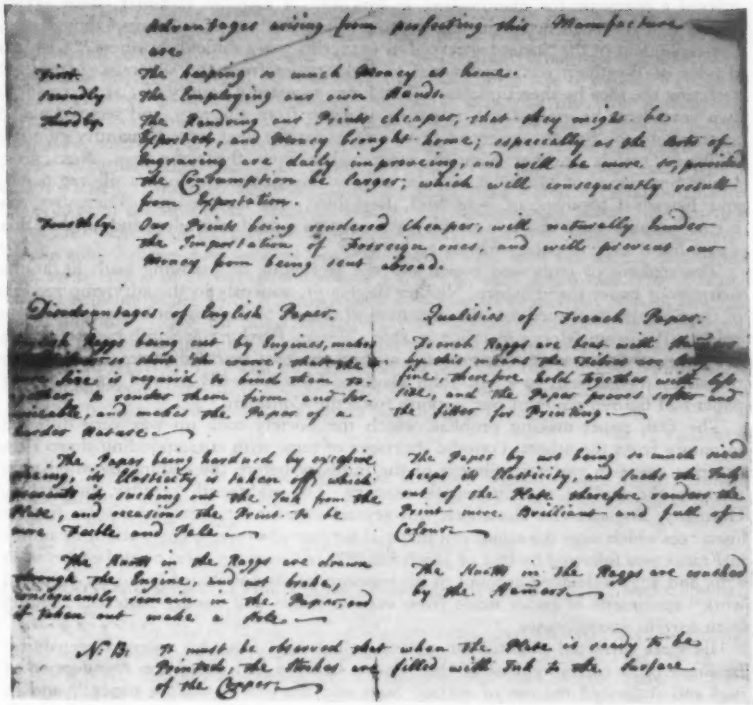
for they are all part of the English effort to make the more varied or higher-quality papers for which continental European producers were famous. The English industry, after a faltering childhood in the sixteenth century, had acquired maturity in the later seventeenth and now in the eighteenth was growing to respectable proportions behind a protective tariff wall which became stouter as the century progressed. As domestic production rose, imports fell. But, as a contemporary put it in 1747, 'We are but lately come into the Method of making tolerable Paper; we were formerly supplied with that Commodity from France, Holland and Genoa, and still are obliged to these Countries for our best Papers'.[1] Ten years later, although imports were even lower they still included much of the highest-quality paper used in the country.

It is against this background, then, that we must trace the story of the Society's attempts to encourage the making of paper suitable for the reproduction of fine prints. A memorial—undated, but thought to have been written in 1756—informed the 'Noblemen and Gentlemen of the Society for encouraging Arts and Manufactures' of the desirability of making such paper, made the usual complaints that we had to import it from France, and then set out an interesting comparison of English and French paper.[2]

Disadvantages of English Paper	*Qualities of French Paper*
English Raggs being cut by Engines, make the Fibres so short, tho' coarse, that the more Size is required to bind them together, to render them firm and serviceable, and makes the Paper of a harder nature.	French Raggs are beat with Hammers, by this means the Fibres are long and fine, therefore hold together with less size, and the Paper proves softer and the fitter for Printing.
The Paper, being hardened by excessive sizeing, its Elasticity is taken off, which prevents its sucking out the Ink from the Plate, and occasions the Print to be more Feeble and Pale.	The Paper, by not being so much Sized, keeps its elasticity, and sucks the Ink out of the Plate, therefore renders the Print more Brilliant and full of Colour.
The Knotts in the Raggs are drawn through the Engine, and not broke; consequently remain in the Paper, and, if taken out, make a Hole.	The Knotts in the Raggs are crushed by the Hammers.

From this comparison, and from other correspondence to the Society of the same period, it is clear that the English industry did make paper of a type suitable for copper-plate printing, though not of a quality equal to the products of the French mills. The latter, however, were expensive (they bore a very stiff import duty): a ream of French Royal suitable for mezzotints cost £3, the equivalent English product only 35*s*.[3] The reference in the memorial to the 'engines' which cut the rags in England is a tribute to the then fairly recent introduction into the English industry of the beating engine or 'Hollander'.[4] The use of this device, developed in the 1670s and '80s in Holland, spread from its country of origin to England in the first half of the eighteenth century, but penetrated only very slowly into the French industry, which was still relying upon the hammers of the ancient stamping mill at a much later date. The beating engine raised productivity in paper manufacture and effectively shortened the rag-preparation process but, if the memorial is to be believed, it was not, at any rate in the earlier days of its use in England, as efficient as the old stampers in the preparation of rags for making the highest quality of papers.

So it was decided to offer premiums to encourage improvements which would bring English paper of this type up to the French standard. The rewards normally took two forms: £25 (or silver medal) for that nearest to French quality, and £50 (or a gold medal) for that equal in quality to the French. Before this arrangement came into operation, however, a reward of 7 guineas was paid in 1757 to a Mr. Taylor—presumably Clement Taylor, paper-maker of Wrotham, Kent, who received other rewards from the Society and was a leading figure in the industry in the



Advantages arising from perfecting this Manufacture are.

First. The keeping so much Money at home.

Secondly. The employing our own Hands.

Thirdly. The Rendring our Prints cheaper, that they might be Exported, and Money brought home; especially as the Arts of Engraving are daily improving, and will be more so, provided the Consumption be larger; which will consequently result from Exportation.

Fourthly. Our Prints being rendered cheaper, will naturally hinder the Importation of Foreign ones, and will prevent our Money from being sent abroad.

Disadvantages of English Paper.

English Raggs being cut by Engines, makes [illegible] shorter than the weave, that the [illegible] is required to bind them together, to render them firm and serviceable, and makes the Paper of a harder Nature.

The Paper being hardned by excessive pressing, its Elasticity is taken off which prevents its sucking out the Ink from the Plate, and occasions the Prints to be more Feable and Pale.

The Knotts in the Raggs are drawn through the Engine, and not broke, consequently remain in the Paper, and if taken out make a Hole.

Qualities of French Paper.

French Raggs are best with the Hand, by this means the Fibres are the finer, therefore hold together with less Size, and the Paper proves softer and the fitter for Printing.

The Paper by not being so much pressed keeps its Elasticity, and sucks the Ink out of the Plate, therefore renders the Print more Brilliant and full of Colour.

The Knotts in the Raggs are washed by the Manufacturer.

N.B. It must be observed that when the Plate is ready to be Printed, the Holes are filled with Ink to the Surface of the Copper.

Extract from R.S.A. Guard Books, Vol. III, No. 43 [? 1756]: The engines for cutting 'English Raggs' were the Dutch-invented beating machines known as 'Hollanders'. This memorial is important as one of the first pieces of unmistakable evidence of their use in England in the eighteenth century

eighteenth century. Thereafter, various claims were made on the Society for these rewards: some were not allowed at all, some received the £25 premium. In 1763 and again in 1764, Thomas Cooke, a paper-maker whose mill was at Tottenham, received the £25 prize.[5] There followed a long period during which no awards were made. In 1785, the Committee of Manufactures, having decided of two specimens of paper submitted to them that they were not equal to French paper, resolved nevertheless that there 'appears to be an evident Improvement in the Manufacture of them when compared with any hitherto produced to the Society'.[6] No award was made, but in 1786 the silver medal went to William Lepard, who was both a paper-maker, with mills near Watford, and a stationer of Newgate Street. Finally, in 1787,[7] John Bates, whose mill was one of the many on the little River Wye, near High Wycombe, Buckinghamshire, received the gold medal, his paper being adjudged equal to, or even better than, French paper.[8] The premium was then discontinued.

It was presumably supposed that silk rags should be able to produce smooth and silky paper. So, whilst the chemistry of paper-making remained in the dark distance,

various persons laboured with silk rags to produce drawing papers and the Society offered a premium for manufacture in this way. A London stationer, John Styles, seems to have been active in encouraging the collection of silk rags,[9] though as a correspondent of the Society observed in 1757, this was a difficult business.[10] Clement Taylor of Wrotham was approached to make paper from the silk rags. After first rejecting the idea he then undertook it and was awarded a bounty of £25 5s. in 1757; two years later he made some 20 reams of paper from silk rags, and secured a £20 award from the Society, a second prize of £10 for the next largest quantity going to William Quelch, another Kentish paper-maker from the same area. Next year, James Simmonds of Midhurst, Sussex, secured the £20 award for his silk rag paper, and Francis Chapman, of Tile Mill, Berkshire, was runner-up.[11] Thereafter, no further awards were made, a testimony maybe to a gradual understanding that this was a blind alley in paper-making technology.

The making of embossed paper and the technique of marbling both lie at the margins of paper manufacture. Neither figures prominently in the surviving records of the Society. A reward for 'the invention of the art of making embossed paper' was paid to Benjamin Moore in 1764; in 1763, Messrs. Portbury & Smith had secured a premium of £50 from the Society for making the best marbled paper, and in 1789 the silver medal went to a Mr. John Davis of Fleet Street.[12] Both of these sorts of paper had figured amongst our imports from the Continent.

The fifth paper-making problem which the Society took up was very different in nature from the others. Periodic shortages of rags, with corresponding sharp rises in price, were an endemic ailment of the industry before the coming of wood-pulp towards the end of the nineteenth century. The eighteenth century, in France, Germany, England and elsewhere, saw several experiments with substitutes for the linen rags which were the major raw material for manufacture.[13] The work of Réaumur in France was followed by that of Jacob Schäffer in Germany, who published between 1765 and 1771 a detailed account of his experiments and included in his six-volumed work[14] specimens of paper made from various plants and sundry materials ranging from turf to wasps' nests.

His work attracted attention in places well distant from his native Regensburg. In England, a correspondent of the Society in 1763 had noted the rising price of rags and suggested the use of nettles, hops and the like in making paper;[15] and in 1768, the Society, impressed by Schäffer's work, awarded him a silver medal for his experiments.[16] In 1774, the Society had written to the leading English paper-maker of the day—James Whatman—and asked him his views on the possibility of making paper from raw cotton, a parcel of which they had received from Jamaica. Whatman's reply was polite but hardly encouraging. He thought, however, that 'the Society would do our Manufacture an essential service if, by Advertisements or any other means, they could induce the Publick to be more careful in saving their rags'.[17] Later, the Society offered a premium of 10 guineas for 'the greatest quantity, not less than 10 reams, of the best and most useful Paper from vegetable substances not previously made into cloth'.[18] In 1787 a silver medal, and in 1789 a bounty of 10 guineas were awarded to Thomas Greaves, paper-maker of Mill Bank, near Warrington, for paper made from the bark of withies;[19] and in 1801, when rag prices were still higher, a premium of 20 guineas was paid to Thomas Willmott, of Shoreham, Kent, for making paper from jute.[20]

What impact did the Society's premiums have on the development of the English paper industry? The answer is probably—very little. In the first volume of the Society's *Transactions* in 1783, there are claims that the making of paper from silk rags, for copper-plate printing, embossed and marbled had all been 'established or promoted'.[21] But in reality the first was a mis-directed effort, though the *Transactions* had apparently not then become aware of this, and the third and fourth were of

relatively small importance in the main stream of the paper industry's growth. As for high-grade printing paper, it is perhaps an odd comment on the effectualness of the Society's encouragement that the outstanding paper-maker of the time apparently never bothered to submit his paper to the Society. James Whatman had already in 1773 made for the Society of Antiquaries an especially large size of paper for copper-plate engraving, 'as no Paper of the size was made at any of the Mills in Europe', to specifications which, *inter alia*, required that the paper should 'approach, as near as maybe, to that of the French'.[22] This may mean, of course, that however good his paper, Whatman knew that the French was still better and that his pride (which was not absent) prevented him from competing in a trial in which he could not ensure his receipt of the first prize. Mere conjecture: but whatever the reason, the absence from the Society's deliberations or competitions of a man of Whatman's stature and known achievements does seem to lessen the respect accorded to its claims. Nevertheless, these efforts to encourage the production of this very specialized type of high-quality printing paper—which formed only a very small proportion of total English paper output[23]—were the most important and valuable element of the Society's interest in encouraging the industry. Its promotion of efforts to find rag substitutes in the eighteenth century had no more real success than the numerous other such experiments conducted then and for many years to come, though these efforts may certainly be seen as tributaries to a stream both long and wide.

D. C. COLEMAN

1. R. Campbell, *The London Tradesman* (London, 1947), Chap. XXVI. Details of the industry's growth will be found in D. C. Coleman, *The British Paper Industry, 1495–1860* (Oxford, 1958).
2. R.S.A. Guard Books, Vol. III, No. 43. Anon, n.d.
3. Ibid., No. 50. Anon, n.d.
4. See Dard Hunter, *Paper Making* (London, 1947), pp. 163–6; and Coleman, op. cit., pp. 62–3, 109–111.
5. R.S.A., Minutes of Committee of Manufactures, 2nd March, 1764; R. Dossie, *Memoirs of Agriculture and Other Oeconomical Arts*, Vol. I (London, 1764), p. 14.
6. R.S.A., Minutes of Committee of Manufactures, 15th March, 1785.
7. Ibid, 1785–6.
8. Ibid., 1786–7; *Transactions*, Vol. VI, p. 167.
9. R.S.A. Guard Books, Vol. III, No. 31. Anon, n.d.
10. Ibid., No. 79. J. Davidson, 1757.
11. Ibid., Vol. III, No. 87, C. Taylor 1757; Vol. IV, Nos. 12, C. Taylor, n.d., 17, C. Taylor, 1759, etc.; Dossie, op. cit., Vol. I, p. 14.
12. Dossie, op. cit., Vol. I, pp. 17, 16; R.S.A. Loose Archives, A6/31. W. Hooper, 1764; *Transactions*, Vol. VII, p. 117.
13. See in general on this Hunter, op. cit., p. 312 ff; *British Paper Industry*, pp. 170–4, and *passim*.
14. *Versuche und Muster ohne alle Lumpen oder doch mit einem geringen Zusatze derselben Papier zu machen* (6 Vols., Regensburg, 1765–71).
15. R.S.A. Guard Books, Vol. II, No. 65. Anon, 'J. C.', 1763.
16. Dossie, Vol. III, p. 457; *Transactions*, Vol. VI, p. 159 ff.
17. Thomas Balston, *James Whatman, Father and Son* (London, 1957), pp. 36–7.
18. *Transactions*, Vol. VI, p. 160.
19. Ibid., and pp. 164–6; also Vol. VII, p. 111 ff.
20. Ibid., Vol. XIX, pp. 235 ff.
21. Ibid., Vol. I, pp. 35–6.
22. Balston, op. cit., pp. 28–34.
23. See Coleman, op. cit., pp. 97–9, 350–2.

OBITUARY

We record with regret the deaths of the following three Fellows of the Society:

SIR FRANK BROWN

Sir Harry Lindsay writes:

The late Sir Frank Brown, C.I.E., whose death on 14th February could only receive a brief notice in the last issue of this *Journal* as it went to press, was one of the most lovable of men. His first experience as a journalist in India was gained with *The Bombay Gazette* as assistant editor for four years, and then for three more years he was Editor of *The Indian Daily Telegraph*.

Invalided home, he continued his successful career as a journalist, and with it his interest in Indian affairs, writing both for many English and Indian papers on Anglo-Indian relations. India remained, indeed, the absorbing topic of his life. He had a most happy capacity for making friends with members of both races. His knowledge of India, and especially of Indian politics, was in consequence deep and wide, for at heart he was an ambassador to both nations, and he never flagged in this rôle, making the objectives and methods of either country better known and appreciated by the other.

In 1940 Sir Frank became a Fellow of the Royal Society of Arts and during the same year he joined the India and Burma Section Committee of the Society, continuing as a member (until his death) of the Commonwealth Section Committee, into which the India and Burma Section was absorbed in 1951, and giving to both Committees most valuable advice from his many contacts with the East. Indeed, for some years before he had been in touch with the Society, and had acted as a close link between it and the East India Association, of which he had become the Honorary Secretary in 1927.

In 1954 failing eyesight compelled Sir Frank to give up many of his principal duties—as a member of *The Times* staff, as Member of Council of the Royal Society of Arts (a position to which he had been elected in 1941) and as Honorary Secretary to the East India Association. But his interest in Indian affairs and in the Society never slackened. It was at his suggestion that Professor M. S. Sundaram (Education Counsellor to the High Commissioner for India) was invited to give this year's Birdwood Memorial Lecture to the Society on 'A Century of British Education in India, 1857–1957'; and on Professor Sundaram's consent to give the lecture on Tuesday, 17th March, Sir Frank had agreed to take the Chair; his place as chairman on that occasion was taken by Sir John Sargent.

Sir Frank's death is a grave loss to the Society, particularly to its Indian interests. Quiet, wise, always friendly, always ready to assist from the wide range of his experience—truly Sir Frank was typical of the many Commonwealth experts who find a deep pleasure in giving of their selfless best to the cause they serve.

PROFESSOR R. C. FITZGERALD

Mr. Richard Charles Fitzgerald, LL.B., Professor of English Law in the University of London, died on 4th February, aged 53. Educated at Birkbeck College and University College, London, he was admitted a solicitor of the Supreme Court in 1937 and combined the practice and the teaching of law for a number of years. During the recent war he was British Council Lecturer in Constitutional Law to lawyers and senior civil servants of the Allied Governments in London, and also taught the same subject at Birkbeck College. In 1948 he was appointed Reader in English Law at University College, and became Professor in 1953. Professor Fitzgerald had been Chairman of the University Board of Examiners in Law, and Dean of the Faculty of Laws, since 1955. He was elected a Fellow of this Society in 1934.

MR. A. G. M. MICHELL

Mr. Anthony George Maldon Michell, F.R.S., the Australian engineer, who was perhaps best known for his work on the theory and practice of lubrication, died in Melbourne on 17th February, aged 88.

Michell was born in London, and attended schools both in this country and Australia before graduating from the Melbourne University Engineering School in 1895. The succeeding years brought him varied experience of structural and hydraulic engineering, and saw the birth of his first invention, a regenerative centrifugal pump (devised in association with the late Bernard A. Smith), which soon proved its value in irrigation works. He set up as a consulting engineer on his own in Melbourne in 1903, and two years later published a mathematical extension of the Osborne Reynolds theory of lubrication, on which extension Michell based his idea for the tilt-pad bearing—a considerable advance in itself, this had a formative influence on the development of many types of machinery. Among his subsequent inventions should be mentioned a thrust bearing, a viscometer, and two types of crankless engines.

Michell was not only an outstandingly able mathematician, and a successful practising engineer responsible for the design of a number of important hydraulic and hydro-electric works, but an enterprising man of business. He founded two companies to market his inventions: Michell Bearings Ltd., at Newcastle-upon-Tyne in 1920, and the Michell Crankless Engineering Corporation at New York in 1928. He was elected a Fellow of the Royal Society in 1934, and had been a Fellow of the Royal Society of Arts since 1939.

NOTES ON BOOKS

GRAPHIS ANNUAL 1958–9. *Edited by Walter Herdeg.* (*Associate Editors: Charles Rosner, Kim Taylor.*) *Zürich, Graphis Press.* (*London, Sylvan Press, 87s 6d net*)

MODERN PUBLICITY 1958–9. *Edited by Frank A. Mercer. London, The Studio,* 1958. *45s net*

These two volumes superficially seem alike, that is to say they are about the same size (*Graphis Annual* has 200-odd pages; *Modern Publicity*, 150-odd pages), they are both well bound in cloth and both have smart, shiny dust jackets with fascinating designs on them. The exciting *Graphis* jacket is in four colours by the Italian-Swiss designer, Celestino Piatti; and the jacket for *Modern Publicity* is in two colours only with a dramatic brush style '28', executed in typical Japanese fashion by Hiroshi Ohchi.

One book costs nearly twice as much as the other. This variation I suppose can be accounted for by the fact that while *Modern Publicity* is a home production, *Graphis Annual* is imported from Switzerland. There is thus an implied extra quality in *Graphis* because of this. The number of countries covered is 23 and of the 782 illustrations, 75 are in colour, whereas the much cheaper *Modern Publicity* covers many more countries (37) and has many more illustrations, namely 1,000, of which 133 are in colour. It would be wrong, however, to assume that you get 'quality' in one and merely 'quantity' in the other. One must take into account that *Graphis* is printed in three languages: English, French and German; whereas *Modern Publicity* is only in English. Although this has little significance for the English and American reader of *Graphis*, it is of great value to the Continental reader—and it must represent considerable costs in time and production for the Swiss publishers.

It is true that with a smaller number of pages in *Modern Publicity*, the inclusion of so many illustrations has meant putting far more on each page. In consequence many of them are quite small. For example, in *Graphis* there is an average of six to eight illustrations per spread; in *Modern Publicity* the comparatively rare minimum

is eight per spread, the majority of spreads have as many as eighteen and, often, twenty-one or twenty-four illustrations.

It might be assumed that because both of these volumes deal with international graphic work their contents would tend to overlap. Although artists and designers from all over the world have undoubtedly submitted the same work to both editors, it has not followed at all that the choice has been in any way identical. It is true that in one or two instances the same design has been reproduced in both books—but in the main it is interesting to see the different kind of approach the two editors have brought to the problem of selection from approximately the same mass of material. As can be expected, the result of their scrutiny is fascinating and of the highest standard in both volumes. The editors are to be congratulated. It cannot have been easy to go through the enormous quantity of work from so many countries and give each example the careful attention that must have been given to present to us such a diverse showing of international standards of design.

As far as subject-matter is concerned, of course, both books deal with the same sort of material, namely: posters; Press and magazine advertisements; direct mail (i.e., catalogues, folders, invitation cards and programmes); magazine covers; gramophone record covers; book jackets; trade marks; packaging. *Graphis* deals also with TV and film advertising design—an interesting section, since this is becoming an increasingly important field of graphic activity.

Both books are really indispensable: for practising designers to whom it is essential to know what work is going on in the world; for students who must always be revising their standards of the kind of work to study and perhaps emulate; for businessmen who are, or should be, concerned with a high standard of design in all aspects of their company's activities in the public eye.

It is becoming almost axiomatic to-day that good business cannot exist without good design. What is good design? Perusal of these two volumes may not necessarily answer this question but a study of the examples shown certainly gives a very good idea of what leading industrialists and businessmen throughout the world are using, and what leading designers are producing. One is impressed not only with the variety and ingenuity of the works illustrated in both annuals, but particularly with the high standard of æsthetic expression which the majority of the examples demonstrates.

ASHLEY HAVINDEN

HANDWRITING. A NATIONAL SURVEY. *By Reginald Piggott. London, Allen & Unwin, 1958. 25s net*

Ever since 1906, when Edward Johnston published his now famous book on lettering, a vast amount of literature has been produced on this subject. Mr. Piggott tells us that 'since 1950 over fifty textbooks, copybooks and manuals' on italic writing alone have been published. His book, however, is not just another textbook nor does it deal solely with the legible italic hand, for we are treated to 418 examples of handwriting by people in various walks of life, of varying ages and using widely differing pens in an extraordinary assortment of styles. The author gives us 105 examples of his own handwriting and 37 exceedingly clear diagrams, including one which shows how to fill a fountain pen. There are also 17 specimens from other people's copy-books.

Divided into two sections, the Survey first attempts to show the prevailing styles of handwriting in use to-day, the pens used, slopes produced and the resulting legibility. The conclusions are based on this evidence tabulated in the form of 'graphs'. The second section is the Piggott plan for better handwriting, with special reference to choice of pens, paper and layout. It is interesting to note that throughout the book only six teachers of lettering are mentioned and all of them are dead. However, there is a clue that at least one living person is carrying on the good work besides the author, for on page 88 in the example of handwriting from an embroidery teacher we find half of a very familiar name in the world of lettering.

The title 'National Survey' is misleading, for the author admits to having examined only 'over 25,000' specimens of current handwriting sent in response to advertisements placed in professional and trade journals and national newspapers. Obviously the specimens were from readers interested in his project. What of the 48,816,339 who either did not read the appeal, or 'couldn't care less anyway'? The conclusions drawn can hardly be called 'national' for they are only representative of those interested in the author's thesis. For instance, in the matter of coloured ink usage, we learn that violet is used in the ratio of 1·4500, mainly by ballet dancers and entertainers; that is to say, 5 or 6 letters in 25,000 were received in violet ink. One is curious to know the colour ink used by ballet dancers who did not reply to Mr Piggott's. invitation.

In the plan for better handwriting we learn of no new or heretical ideas, but the author has made an interesting comparison between the types of nib on sale to-day. Over fifty examples in his own hand should be a good guide to anyone choosing a pen. Mr. Piggott's choice of writing paper is confused, although the clear layouts for letters may be useful to those deciding to write in a more interesting manner.

In a book dealing with presentation the text should not be constantly interrupted by pages of illustration. This is simply bad typography.

As a whole, the book may have some interest for Fellows who read the appeal made by Mr. Piggott in this *Journal* some time ago.

MICHAEL R. PRESTON

HOUSES AND BUNGALOWS. *By June Park. London, Batsford,* 1958. 45*s net*

It is most interesting to compare this book with similar collections of twenty years ago. These were of two kinds: omnibus compilations like Abercrombie's *Book of the Modern House*, with most of Betjeman's 'Pillar to Post' styles represented and the truly modern house in a small minority out on the far left, and coterie books like McGrath's *Twentieth Century Houses*, written in basic English and confined to the austere vintage products of the International style. Miss Park's collection is (with one exception that could well have been omitted) all inside a far tighter cost bracket, all modern (neo-Georgian, etc., if they still exist, are as firmly censored as in McGrath's book), yet within its frontiers of cost and style there is a great deal of fun and variety, as much, certainly, as has been available within any of the styles of the past. The two main streams, the romantic flowing from Scandinavia and the classic stemming from Mies van der Rohe, have already, as so often in England, diluted one another, and the New Brutalism (the Puritan protest against all this eclecticism and frivolity) seems unlikely to dam up the flood of experiment for long. This restless atmosphere isn't the climate for great architecture, but our world is anyway hardly the place for it.

Miss Park does not attempt these generalizations. Her approach is strictly for the layman, and strictly practical. Planning and construction, services, finishes and fittings, contract procedure and scales of fees are carefully explained in simple language, and it is all perfectly true and correct. The only trouble is that building techniques nowadays are far from simple, and I suspect that Miss Park has found herself drawn further into technicalities than she intended, and further than most laymen would care to follow her. Second-year architectural students will find her text extremely useful, but practising architects may feel that her talents of admirably simple exposition could have been more valuably used to explain something of the genesis of modern house design and to win for them a little more understanding of their own admirably simple and highminded approach to architecture.

The author leaves that to the illustrations, and very cleverly chosen they are, with something for all tastes yet nothing quite outside the canon of modern architecture. Two perennial problems in this type of compilation have not been solved, namely the standardization of plans and the standardization of cost figures. The latter may be too much to ask, since external works and internal fittings introduce so many

variables, but it does seem a pity that the plans could not all have been drawn to the same scale.

But it would be quite wrong to leave a preponderant impression of criticism of a charming book. Only a dyed-in-the-wool aesthetic Scrooge could resist the appeal of these delightful houses.

LIONEL BRETT

MINOR ENGLISH WOOD SCULPTURE, 1400–1550. *By Arthur Gardner, London, Tiranti, 1958. 25s net*

Mr. Arthur Gardner is the *doyen* of English medievalists; there can be hardly any of the later generations who have not learned the basis of what they know of English sculpture of the Middle Ages from his books. The thousands of photographs taken by him and his father, Mr. Samuel Gardner, long ago set a standard in illustration: a standard now, perhaps, surpassed by those who use flashes and reflectors, as they did not, but still an honourable one.

This book, largely based on a long article previously published in the *Journal of the British Archæological Association*, is devoted to the bench-ends of the fifteenth and early sixteenth centuries that are to be found in English parish churches. It is not concerned with the more splendid stalls of the cathedrals and collegiate churches; these have in recent years been admirably dealt with by Miss M. Anderson. Mr. Gardner's subject is much more homespun. The bench-ends of the English parish churches do not seem to have been mass-produced in cities, but to have been made by carpenters working in the locality. They may portray anything from shields of arms or the grotesques that recall the infinite variety of the 'babewyns' of contemporary illumination to figures of saints and illustrations of such scenes as the Annunciation or the Resurrection; but they never touch the limits of great art. Furthermore they have no consistent historical or didactic iconography such as is found in the stained glass of the humblest church, imported from the nearest centre of the industry; they represent the fancy of country carpenters and are of the earth, earthy.

Their distribution lies, broadly speaking, in the two great provinces of East Anglia and the West Country. The poppy-head finial is characteristic of the first, and square-topped bench-ends of the second. The East Anglian carpenter, like the East Anglian illuminator, had an insatiable taste for grotesques which was little shared by his West Country colleague. The Western bench-ends, indeed, are for the most part late, with signs of Renaissance influence in their roundels and wreathed foliage; they offer many comparisons with secular joinery in chests and chairs. Mr. Gardner deserves our thanks for a study that will make us look with fresh interest at any bench-ends that may have survived in the churches we enter.

JOAN EVANS

SHORT NOTES ON OTHER BOOKS

THE YEAR'S PHOTOGRAPHY, 1958. *London, Royal Photographic Society, 1958. 10s 6d*

Contains reviews of photographic art and of natural history photography, and a selection of pictures from the exhibitions held at the Royal Photographic Society's house during the past year. Of particular interest to the historian are the plates from the Salomon exhibition, which include informal photographs taken at the Lausanne Disarmament Conference in 1932.

RENDERING TECHNIQUES FOR COMMERCIAL ART AND ADVERTISING. *By Charles R. Kinghan. New York, Reinhold, 1957. (London, Chapman and Hall, £5 8s net)*

The author discusses, and illustrates abundantly, essential tools, simple perspectives, types of layouts and roughs, colour, figures in action, value relationships,

and problems of specific subjects. Mr. Kinghan is a well-known and successful American commercial artist and his book should be useful both to those intending to enter, and those already practising, in this field.

THE MOSQUITO MAN. *The Story of Ronald Ross. By John Rowland. London, Lutterworth,* 1958. 9*s* 6*d net*

'The story of Ronald Ross . . . is essentially the story of Malaria.' The author has accordingly devoted the greater part of this short biography to an account of Ross's work in India and the tropics, but the importance of his research in this country on tropical diseases is also made clear.

FROM THE JOURNAL OF 1859

VOLUME VII. 22*nd April*

INGENIOUS 'MISCELLANEA'

[*From the Catalogue of the Eleventh Annual Exhibition of Inventions, held at the Society's House during the spring of* 1859.]

358. Patent Renewable Stocking:
H. Owen, Swiss Cottage, Portswood, Southampton.

This stocking is so manufactured as to admit of the removal of the worn parts, and the supply of new, with no risk of disturbing the fabric, and without the necessity of darning or over-lapping. By removing the worn parts, and supplying, at a trifling cost, a new sole or heel, the stocking will be made equal to new, and this operation can be performed in a few minutes. The woodcut shows the arrangement of the seams.

365. Patent Perambulator:
J. B. Thomber, Great Russell Street, Bloomsbury, W.C.

This perambulator is so constructed that it can be made a double or a single, and a closed or an open carriage, with windows, or a bed. The body of the carriage forms a little more than a half circle, with slots or grooves inside, in which a semi-circular hood or cover, made of light material, slides. The sides contain glass windows, moving on an axle, and capable of being turned up or down, so as to be a partial or an entire cover from both rain and sun. One seat folds so as to form a bed. There is a screw in the axle and spring, whereby to raise or lower the back of the carriage.

Some Activities of Other Societies and Organizations

MEETINGS

WED. 25 MARCH. Kinematograph Society, British, at Royal Society of Arts, John Adam Street, W.C.2. 7.30 p.m. T. E. Knight, R. de B. McCulloch: *Lighting for film and television studies.*
Victoria & Albert Museum, South Kensington, S.W.7. 6.15 p.m. Alan Reed: *William Morris and the anti-scrape.*

THURS. 26 MARCH. Petroleum, Institute of, at 61 New Cavendish Street, W.1. 6 p.m. C. G. Tresidder: *The purpose of additives in modern gasolines.*

WED. 1 APRIL. Victoria & Albert Museum, South Kensington, S.W.7. 6.15 p.m. Robert Charleston: *Swedish pottery and porcelain.*

THURS. 2 APRIL. Refrigeration, Institute of, at The Memorial Building, 76 Mark Lane, E.C.3. 5.30 p.m. W. R. Hall: *The measurement and determination of noise in small refrigerating machines.*

SAT. 4 APRIL. Interplanetary Society, British, at Caxton Hall, S.W.1. 6 p.m. C. M. Cade: *Some implications of radio astronomy in the fields of navigation, guidance and communication.*

MON. 6 APRIL. Engineers, Society of, at Burlington House, Piccadilly, W.1. 5.30 p.m. George Constantinesco: *Sonics.*

TUES. 7 APRIL. Architects, Royal Institute of British, 66 Portland Place, W.1. 6.30 p.m. Bryan H. Harvey: *Early industrial architecture.*
Civil Engineers, Institution of, Great George Street, Westminster, S.W.1. 5.30 p.m. L. R. Creasy: *Economics of framed structures.*

WED. 8 APRIL. Chemical Society, at Friends House, Euston Road, N.W.1. 10.30 a.m. Professor H. J. Emeleus: *Some inorganic polymers.*

FRI. 10 APRIL. Mechanical Engineers, Institution of, 1 Birdcage Walk, S.W.1. 6 p.m. D. L. Pratt: *The performance of vehicles under trans-antarctic conditions.*

MON. 13 APRIL. Engineering Designers, at 6 Higham Place, Newcastle-upon-Tyne 1. 7.15 p.m. W. J. Grant: *Plastics and the engineer.*
Geographical Society, Royal, 1 Kensington Gore, S.W.7. 8.30 p.m. Lieut. N. C. Flemming: *The underwater exploration of ancient Apollonia.*

TUES. 14 APRIL. Metals, Institute of, at Royal Institution, Albemarle Street, W.1. 7 p.m. Professor F. Hoyle: *The scientific uses of space exploration.*

THURS. 16 APRIL. Public Health Engineers, Institution of, at Caxton Hall, S.W.1. 6 p.m. R. E. Wagg: *Laundering processes—water and effluents.*

TUES. 21 APRIL. Architects, Royal Institute of British, 66 Portland Place, W.1. 6.30 p.m. J. Clancey and A. J. M. Tolhurst: *Sanitation within buildings.*
Petroleum, Institute of, at 61 New Cavendish Street, W.1. 6 p.m. Dr. J. Burns: *Oil in the gas industry.*

THURS. 23 APRIL. Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. Sir David Blunt: *The Geophysical Year 1957–8.*
Road Transport Engineers, Institute of, at Royal Society of Arts, John Adam Street, W.C.2. 6.30 p.m. R. Cox: *Trends in modern road passenger transport.*

OTHER ACTIVITIES

NOW UNTIL MON. 30 MARCH. Commonwealth Institute, South Kensington, S.W.7. Mon.–Fri. 10 a.m.–4.30 p.m. Sat. 10 a.m.–5 p.m. Sun. 2.30 p.m.–6 p.m. Exhibition of paintings and drawings: *Character of the Commonwealth.*

NOW UNTIL THURS. 26 MARCH. Whitechapel Art Gallery. Exhibition of *Painting and sculpture by people who live or work in East London.*

LIBRARY ADDITIONS

Fellows and Associates are reminded that they may borrow up to five books at a time from the Library and retain them for a month. Members living outside London may borrow books by post. Books sent by post are despatched at the cost of the Society and returned at the cost of the borrower.

HISTORY AND TOPOGRAPHY

LIPSON, EPHRAIM—An introduction to the economic history of England. 1. The Middle Ages. *London, A. & C. Black*, 1915.

LIPSON, EPHRAIM—The economic history of England. . . . The age of mercantilism. *London, A. & C. Black*, 1931.

LONDON, NATIONAL MARITIME MUSEUM—A picture book of ship-models, compiled by G. P. B. Naish. *London, H.M.S.O.*, 1953. Presented by the author.

LONDON. NATIONAL MARITIME MUSEUM—Royal yachts: compiled by G. P. B. Naish. *London, H.M.S.O.*, 1953. Presented by the author.

PEVSNER, NIKOLAUS BERNARD LEON—Northumberland; with notes on the Roman antiquities by Ian A. Richmond. *London, Penguin Books*, 1957. (Buildings of England series, No. 12.)

SINGER, CHARLES JOSEPH, *and others, editors*—A history of technology. *Oxford, Clarendon Press.* Vol. 3: From the Renaissance to the Industrial Revolution, 1500–1750, 1957. Presented by Imperial Chemical Industries Ltd.